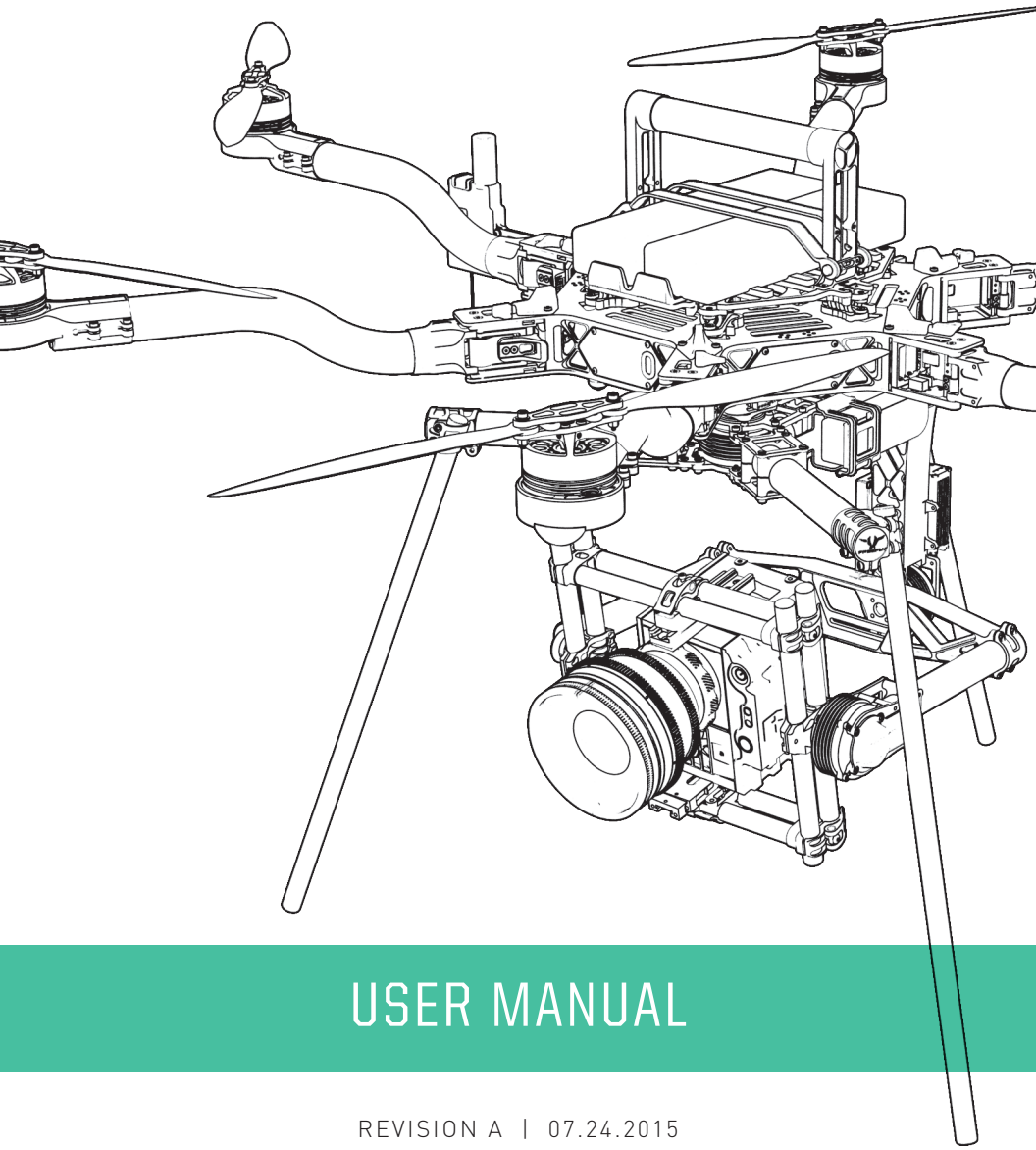
FREEFLY

ALTA



USER MANUAL

REVISION A | 07.24.2015

REVISION HISTORY

REVISION	DATE	DESCRIPTION
A	July 2015	Initial Release

CONTENTS

2 Revision History
3 Contents

5 **ALTA OVERVIEW**
6 Disclaimer and Warning
7 LIMITATION OF LIABILITY
8 Introduction
9 Symbols, Abbreviations and Terminology
12 Dimensions
14 Included Items
15 Specifications
19 Limitations
20 System Diagrams
24 ALTA Mobile App
24 Additional Required Components (not included)

25 **SETTING UP ALTA**
26 Unfolding ALTA
30 Radio Installation
35 Radio Mapping
40 Configuring Top or Bottom Mount
42 Isolator Cartridges
43 Battery Installation
47 Compass Calibration
49 Propellers
51 First Person View (FPV)
54 FPV On Screen Display Setup
58 Tuning ALTA
61 ALTA Flight Parameters

64 **OPERATING ALTA**
65 Flight Controller Modes
67 Home Switch

67 Arm Enable Switch
68 Status Light
70 Orientation Lights
71 ALTA App Monitor

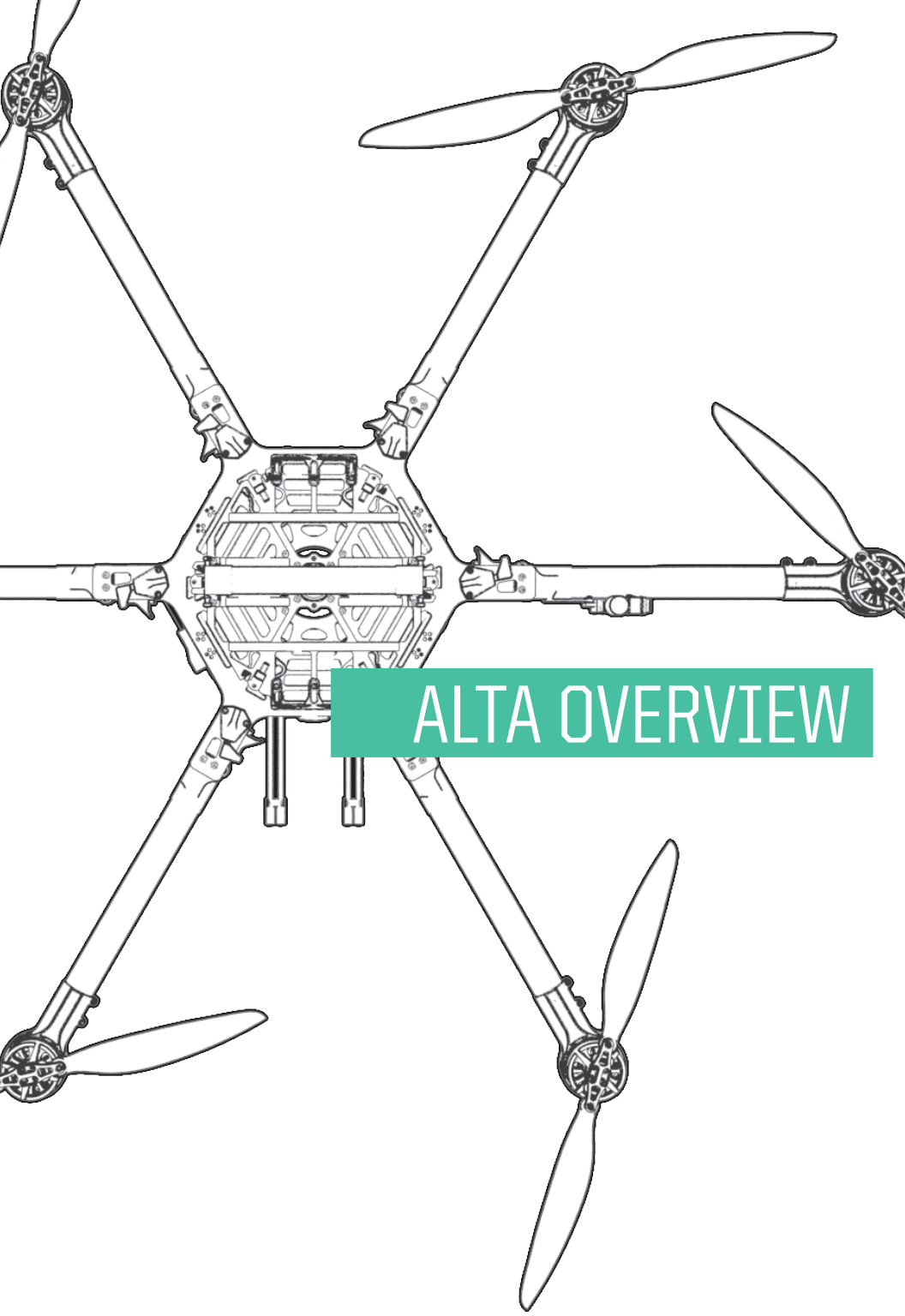
72 NORMAL PROCEDURES
73 Unpacking and Setup
74 Before Starting
76 Before Takeoff
78 After Every Flight
79 After Last Flight

80 EMERGENCY PROCEDURES
81 Emergency Guidance
82 Pilot Disorientation
83 Unexpected Flight Controller Behavior
84 Battery Exhaustion
85 Status Light Warning Indicator Illuminates
86 Loss of Radio Control Signal
87 Loss of FPV Signal
89 Data Logging
89 Performance
89 Weight / Endurance Performance Data

90 MAINTAINING ALTA
91 General Information and Techniques
92 Maintenance Items
95 Replacement of Parts
96 Firmware Update Process

97 TROUBLESHOOTING

100 APPENDIX
101 Appendix A. Default Tuning Values
102 Appendix B. Data Logging Fields



ALTA OVERVIEW

DISCLAIMER AND WARNING

IMPORTANT - Please read this disclaimer and warning carefully and review the ALTA User Manual prior to flight. If you have any questions, please contact support@freeflysystems.com prior to using the ALTA. You can review the most current version of this User Manual at www.freeflysystems.com/software-manuals/.

By using the ALTA, you acknowledge that you have read, understand and agree to this disclaimer. You agree that you are solely responsible for your conduct while using the ALTA, and for any direct or indirect consequences that may result from its use. You agree to only use the ALTA for proper purposes that are in accordance with local and airspace rules and regulations.

- ALTA is not a toy and should be operated with extreme care, as improper operation can cause damage to property, serious personal injury or death.
- As with any multi-rotor helicopter, the ALTA is a complex and technical machine. Novice pilots should invest sufficient time on a flight simulator and seek training from an experienced pilot prior to operation. The ALTA User Manual and a flight simulator are no substitute for training with an experienced pilot, particularly when it comes to learning how to safely operate the ALTA. Novice pilots should never fly without the supervision of an experienced pilot.
- Always check the ALTA and its components prior to operation.
- Always maintain a safe distance from the ALTA when in use.
- Never attempt to touch the ALTA when the propellers are moving.
- Never fly the ALTA over or around people, power lines or other aircraft.
- Never fly with any propellers that have visible imperfections or damage.
- Always keep children and animals a safe distance away from the ALTA when in use and when changing configurations.
- Always remove the propellers or power ALTA using a low power source when making a change to the configuration of the ALTA to prevent propeller strikes in the event of unintentional motor starts.
- Always remove the configuration jumper when making changes to the configuration of the ALTA.
- Always test the ALTA with the propellers removed to make sure that the motors are spinning in the correct direction and that the motor assignment is correct with respect to the SYNAPSE flight controller. If you have either of these wrong, the ALTA will be uncontrollable and dangerous.
- It is your responsibility to perform a full system check of the ALTA prior to every flight.
- It is your responsibility to learn how to safely operate the ALTA and to adhere to all applicable rules and regulations.
- Fly at your own risk.

LIMITATION OF LIABILITY

IN NO EVENT SHALL FREEFLY BE LIABLE TO BUYER FOR ANY INDIRECT, CONSEQUENTIAL, PUNITIVE, INCIDENTAL, OR SPECIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM THE USE OF THE ALTA OR FROM LOSS OF USE, DATA OR PROFITS (HOWEVER CAUSED AND UNDER ANY THEORY OF LIABILITY), EVEN IF FREEFLY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. IN NO EVENT SHALL FREEFLY'S LIABILITY FOR A PRODUCT (WHETHER ASSERTED AS A TORT CLAIM, A CONTRACT CLAIM OR OTHERWISE) EXCEED THE AMOUNTS PAID TO FREEFLY FOR SUCH PRODUCT. NOTWITHSTANDING ANYTHING HEREIN, IN NO EVENT SHALL FREEFLY'S LIABILITY FOR ALL CLAIMS ARISING OUT OF OR RELATING TO THIS AGREEMENT EXCEED THE AMOUNTS PAID BY BUYER TO FREEFLY FOR PRODUCT IN THE LAST TWELVE (12) MONTHS. IN NO EVENT WILL FREEFLY BE LIABLE FOR COSTS OF PROCUREMENT OR SUBSTITUTE GOODS BY BUYER. THE LIMITATIONS SET FORTH HEREIN SHALL APPLY TO ALL LIABILITIES THAT MAY ARISE OUT OF THIRD-PARTY CLAIMS AGAINST BUYER. THESE LIMITATIONS SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY.

Freefly shall not be liable for damages or injuries incurred directly or indirectly from the use of the ALTA including, but not limited to, the following situations:

- Failure of operator to follow proper instructions and safety warnings found at www.freeflysystems.com.
- Failure of the operator to follow onboard safety warnings while using the ALTA.
- Failure of the operator to follow and comply with local rules and regulations.
- Failure of the operator to inspect the ALTA and its components prior to operation.
- Failure of the operator to properly maintain and/or service the ALTA through an authorized Freefly Service Center with genuine ALTA parts.
- Use of third-party products on the ALTA.
- Use of the ALTA in a physically or mentally impaired capacity.
- Use of the ALTA without sufficient training.
- Use of the ALTA in unsafe conditions, including but not limited to, bad or severe weather, such as rain, wind, snow, lightning, dust storms, etc., or in areas of magnetic or radio interference, such as power stations, broadcasting and cell phone towers, government prohibited airspace, etc.
- Improper operation, misjudgment or risky behavior while using the ALTA.
- Infringement of third party data, audio or video rights recorded when using the ALTA.

INTRODUCTION

ALTA is a professional multi-rotor aircraft designed for demanding cinematic, television, and photographic applications. Within five minutes, ALTA can unfold from its carrying case to flying some of the most capable cinema cameras on either the top or bottom of the aircraft. The SYNAPSE flight controller is purpose-built for cinema use, yielding precise, yet smooth control.

This User Manual has been prepared to describe the complete operation of airframe and flight control systems, and the normal maintenance of those items. Do not operate ALTA without reading and understanding this manual.

This manual is not a substitute for adequate flight training. Training requirements can vary when operating in different countries or under different flight conditions. Always consult local regulations before flying ALTA. In areas where there are no flight training requirements, it is the sole determination of the pilot-in-command as to whether he or she has the appropriate level of training or experience for a given flight. Always set and adhere to personal minimums and fly within your own capabilities.

WARNINGS, CAUTIONS AND NOTES

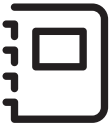
Throughout the manual, warnings, cautions and notes are used to highlight various important procedures. These are defined as follows:

WARNING

Warnings are used to highlight procedures which, if not strictly observed, may result in personal injury or loss of life.

CAUTION

Cautions are used to highlight procedures which, if not strictly observed, may cause damage to equipment.



NOTE

Notes are used to highlight specific operating conditions or steps of a procedure.

SPEED TERMINOLOGY

GS	*Ground Speed* is the speed of an aircraft relative to the ground
TAS	*True Airspeed* is the airspeed of an aircraft relative to undisturbed air

METEOROLOGICAL TERMINOLOGY

ISA	International Standard Atmosphere in which: The air is a dry, perfect gas; The temperature at sea level is 15° Celsius (59° Fahrenheit); The pressure at sea level is 1013.2 mbar (29.92 inches Hg); The temperature gradient from sea level to the altitude at which the temperature is -56.5°C (-69.7°F) is -0.00198°C (-0.003564°F) per foot and zero above that altitude

MSL	Mean Sea Level is the average height above the surface of the sea for all stages of tide
AGL	Above Ground Level is the height of the aircraft above the ground
OAT	Outside Air Temperature is the free air static temperature surrounding the aircraft
Pressure Altitude	Altitude measured from standard sea level pressure (29.92 in. Hhg) by a pressure or barometric altimeter It is the indicated pressure altitude corrected for position and instrument error. In this Manual, altimeter instrument errors are assumed to be zero

POWER TERMINOLOGY

Maximum Continuous Power Output	The maximum typical power output of a motor averaged over the entire flight
Maximum Instantaneous Peak Power Output	The maximum power output of a motor during any phase of flight, such as when maneuvering

FLIGHT AND POWERPLANT CONTROL

Throttle Stick	The radio controller stick responsible for throttle control. For Mode 2 controllers, this is the vertical movement of the left control stick. For Mode 1 controllers, this is the vertical movement of the right control stick
Yaw Stick	The radio controller stick responsible for yaw (also called pan) control For Mode 2 and Mode 1 controllers, this is the lateral movement of the left control stick
Pitch Stick	The radio controller stick responsible for pitch control. For Mode 2 controllers, this is the vertical movement of the right stick For Mode 1 controllers, this is the vertical movement of the left stick
Roll Stick	The radio controller stick responsible for roll control. For Mode 2 and Mode 1 controllers, this is the lateral movement of the right control stick
Pitch/Roll Stick or Cyclic Stick	The radio control stick responsible for both pitch and roll control For Mode 2 controllers, this is the right stick

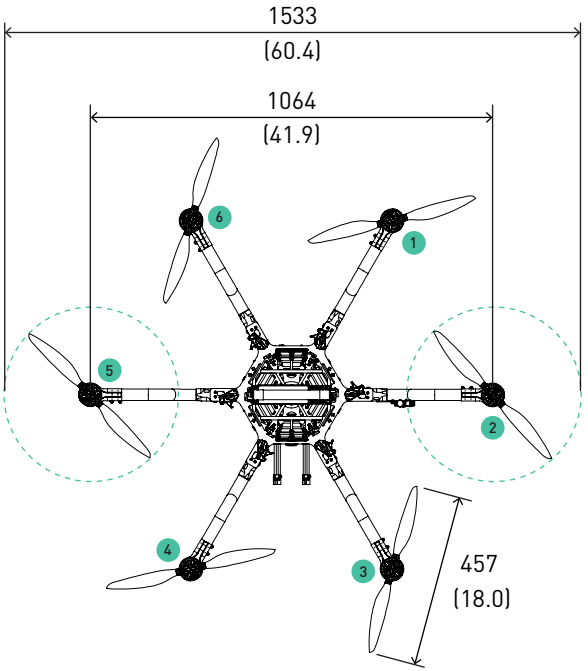
WEIGHT AND BALANCE

Maximum Takeoff Weight (MTOW)	Maximum allowable weight at liftoff
Standard Empty Weight	Weight of a standard aircraft
Basic Empty Weight	Standard empty weight plus optional equipment
Useful Load	Difference between take off weight and basic empty weight
Payload	Useful load less battery weight

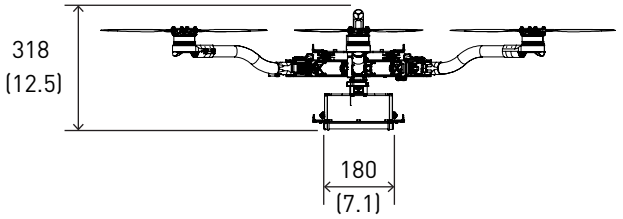
GENERAL TERMINOLOGY

sUAS	Small Unmanned Aircraft System includes all components of the system required for the flight of an unmanned aircraft, including the radio controller, data link and other related support equipment

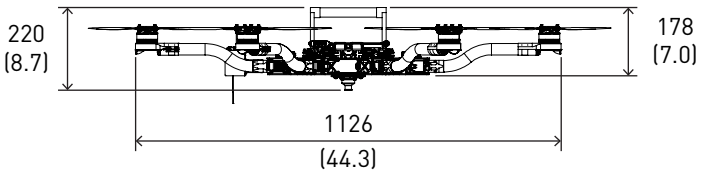
DIMENSIONS



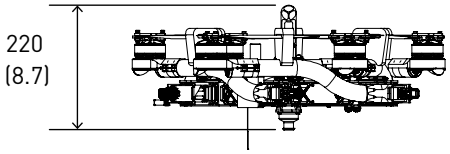
UNFOLDED PLAN VIEW WITH BOOM NUMBERING SCHEME MM (INCH)



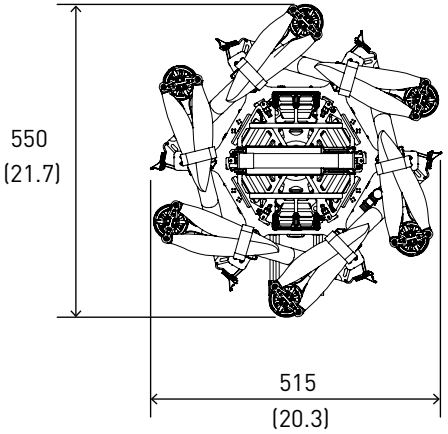
UNFOLDED SIDE VIEW WITH LANDING GEAR MM (INCH)



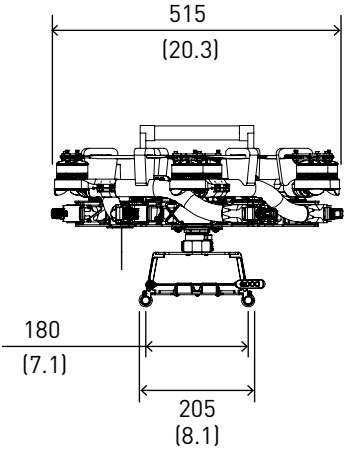
UNFOLDED FRONT VIEW WITHOUT LANDING GEAR MM (INCH)



FOLDED SIDE VIEW MM (INCH)

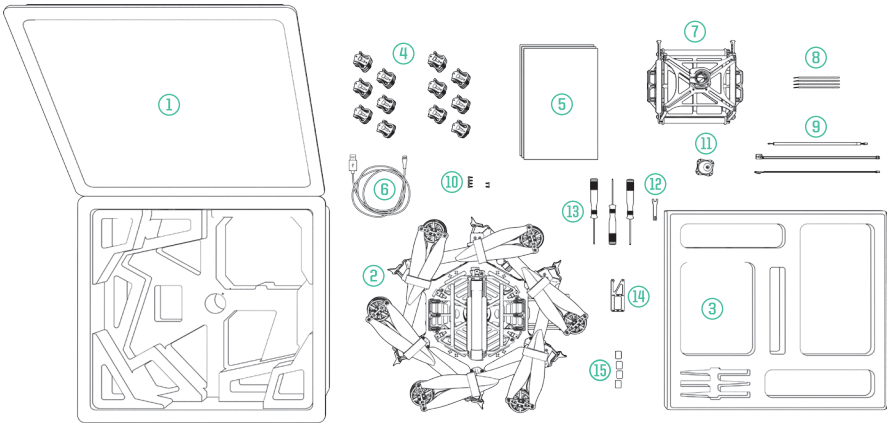


FOLDED PLAN VIEW MM (INCH)



FOLDED FRONT VIEW MM (INCH)

INCLUDED ITEMS



1. Case

2. ALTA

3. Case Lid Foam

4. Isolator Cartridges

- **a.** (6) Teal (Installed)
- **b.** (6) Black
- **c.** (6) Red

5. Documentation

6. USB-Futaba Power Cable

7. Inverted Landing Gear

8. Antenna Tubes

9. FPV Cables

- **a.** Skyzone/BOSCAM
- **b.** ImmersionRC/Fat Shark
- **c.** Ready Made RC

10. Fasteners

- **a.** (4) M3 × 8 Socket Head for Toad In The Hole Male Adapter
- **b.** (2) M3 × 8 Flat Head for Accessory Mount

11. Toad In The Hole Male Adapter

12. 5.5mm Wrench

13. Hex Drivers (1.5mm, 2.0mm, 2.5mm)

14. Accessory Mount

15. Double-Sided Tape

DIMENSIONS

DIAMETER (DOES NOT INCLUDE PROPS)

Unfolded Diameter	1126 mm
Folded Diameter	515 mm
Height to base of Toad In The Hole (TITH)	220 mm

POWERPLANT

Number of Motors	6
Motor Type	Direct Drive 3-Phase PMAC Outrunner
Motor Model	F45
Motor Max Continuous Power Output	350 W
Motor Max Instantaneous Peak Power Output	950 W
Maximum RPM (flat rated)	6300 RPM
Equivalent Kv	384
Electronic Speed Controller	Freefly Silent-Drive Sine Wave ESC

PROPELLERS

Material	Carbon fiber with balsa core
Propeller Orientation	(3) CW and (3) CCW Props
Propeller Type	18 × 6 Folding

BATTERY

Nominal Battery Voltage	6S / 22.2V
Maximum Battery Size	240 × 180 × 80 mm
Maximum Battery Quantity	2 Battery Packs (Parallel)
Battery Connectors	2× EC5 (Parallel)
Required Minimum Battery Discharge Rating	Dual Pack: 200A / 400A Peak Single Pack: 300A / 600A Peak

WEIGHTS

Maximum Gross for Takeoff[1]	13.6 kg (30.0 lbs)
Maximum Useful Load[2]	9.1 kg (20.0 lbs)
Maximum Payload[3]	6.8 kg (15.0 lbs)
Typical Standard Empty Weight:	4.5 kg (10.0 lbs)

SPECIFIC LOADINGS

Typical Specific Power[4]	145 W/kg
Thrust Ratio at MTOW[1]	1.85 : 1

[1] At sea level, ISA.

[2] Top and bottom mount. Includes batteries.

[3] Payload weight top or bottom mount. Battery weight not included and mounted on opposite side from payload.

[4] At MTOW, sea level, ISA.

FLIGHT CONTROLLER

Model Name	Freefly SYNAPSE flight controller
Flight Modes	Manual, Height Mode, Position Mode, Return-To-Home, Autoland
Supported Inputs:	DSMX, DSM2, S.Bus, S.Bus2, PPM, FPV SD
Supported Radios	Futaba S.Bus & S.Bus2, DSMX, DSM2 (Spektrum/JR), PPM, PPM Invert, PPM Graupner
Supported Radio Controller Telemetry Systems	Futaba w/ built-in voltage sense port
Minimum Radio Controller Channels Required	5
Supported GNSS	GPS, GLONASS, Galileo
Supported SBAS	QZSS, WAAS, EGNOS, MSAS
First-Person View System Video Formats	NTSC, PAL
Supported First-Person View Transmitters	Skyzone, BOSCAM, ImmersionRC, Fat Shark
Supported First-Person View Cameras	Ready Made RC
First-Person View OSD Telemetry	User Configurable
Installed Transceivers	Wi-Fi
Data Logging Rate	25 Hz

LIGHTING AND INDICATION

Status Light	1 Watt Red, 1 Watt White
Orientation Lights	3-Watt RGB LED
Orientation Light Color Options	Red, Yellow, Blue, Green, White
Accessory Lighting Port	12 VDC
Accessory Lighting Port Location	Outboard on Boom Ends

ISOLATION SYSTEM

Vibration Isolation System	Silicone O-Rings
Option 1: Soft / Light Payloads	Red O-Rings
Option 2: Medium / Medium Payloads	Teal O-Rings
Option 3: Stiff / Heavy Payloads	Black O-Rings

PAYLOAD MOUNTING

Mounting Locations	Bottom and Top Mount
Mounting System	Freefly Toad In The Hole (TITH) Quick Release
FPV Camera Mount	Forward, underneath chassis
FPV Transmitter Mount	Boom #5

NOTE

These limitations are advisory in nature and do not extend or restrict limitations provided by local aircraft operational regulation.

POWERPLANT LIMITATIONS

Maximum RPM	6300 RPM
Maximum Battery Voltage	25.2 Volts
Minimum Average Battery Voltage	19.2 Volts

ENVIRONMENTAL LIMITATIONS

Do not fly ALTA in temperatures exceeding 45ºC (113ºF) or below -20ºC(-4ºF).[5]

WEIGHT LIMITS

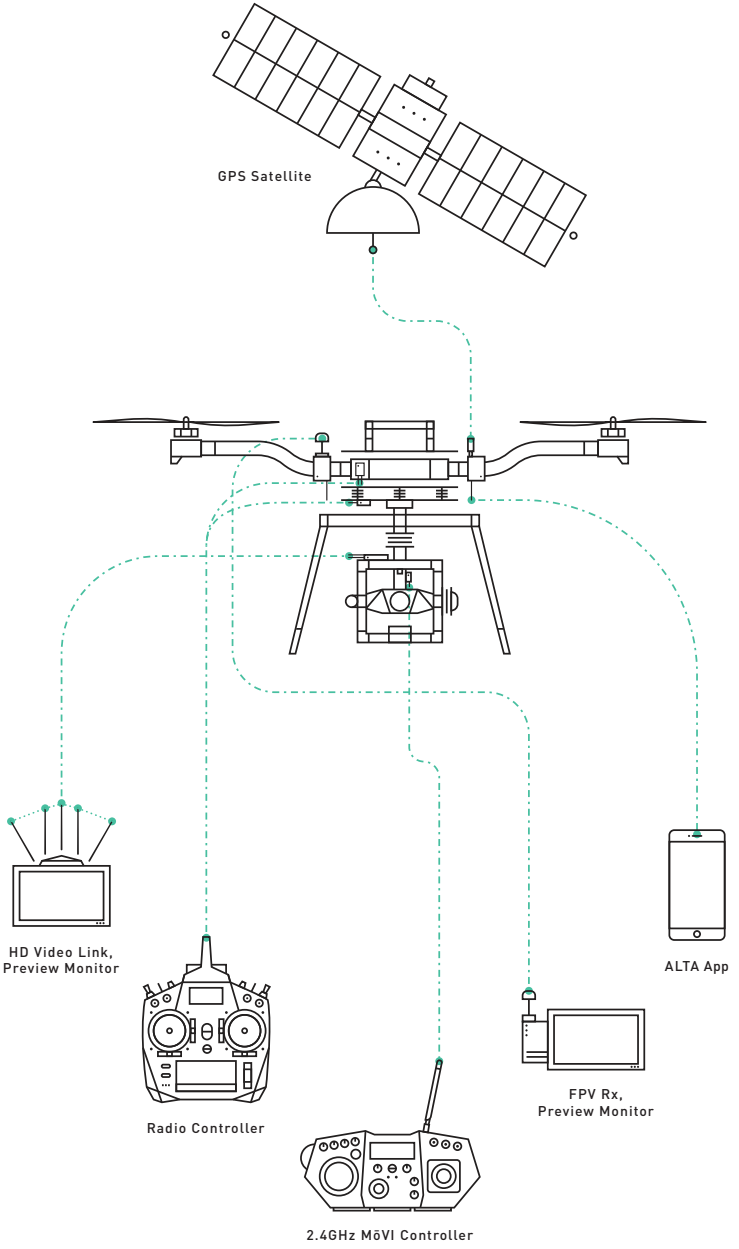
Maximum Takeoff Weight	13.6 kg (30.0 lbs)
Maximum Useful Load	6.8 kg (15.0 lbs)

FLIGHT CONTROLLER LIMITS

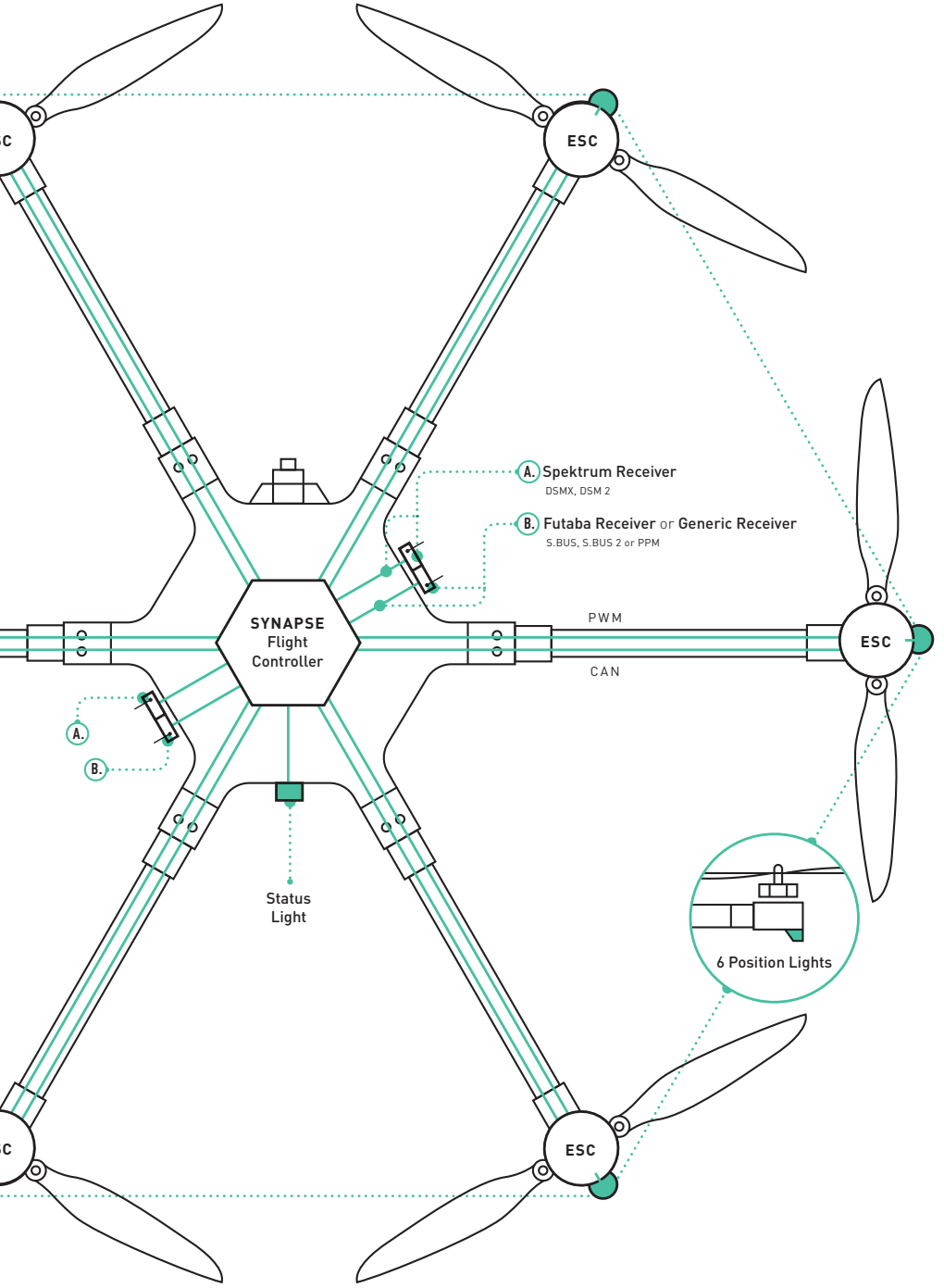
Maximum Pitch/Roll Angle	45°
Maximum Yaw Rate	150° / second

[5] Must additionally observe battery temperature ratings.

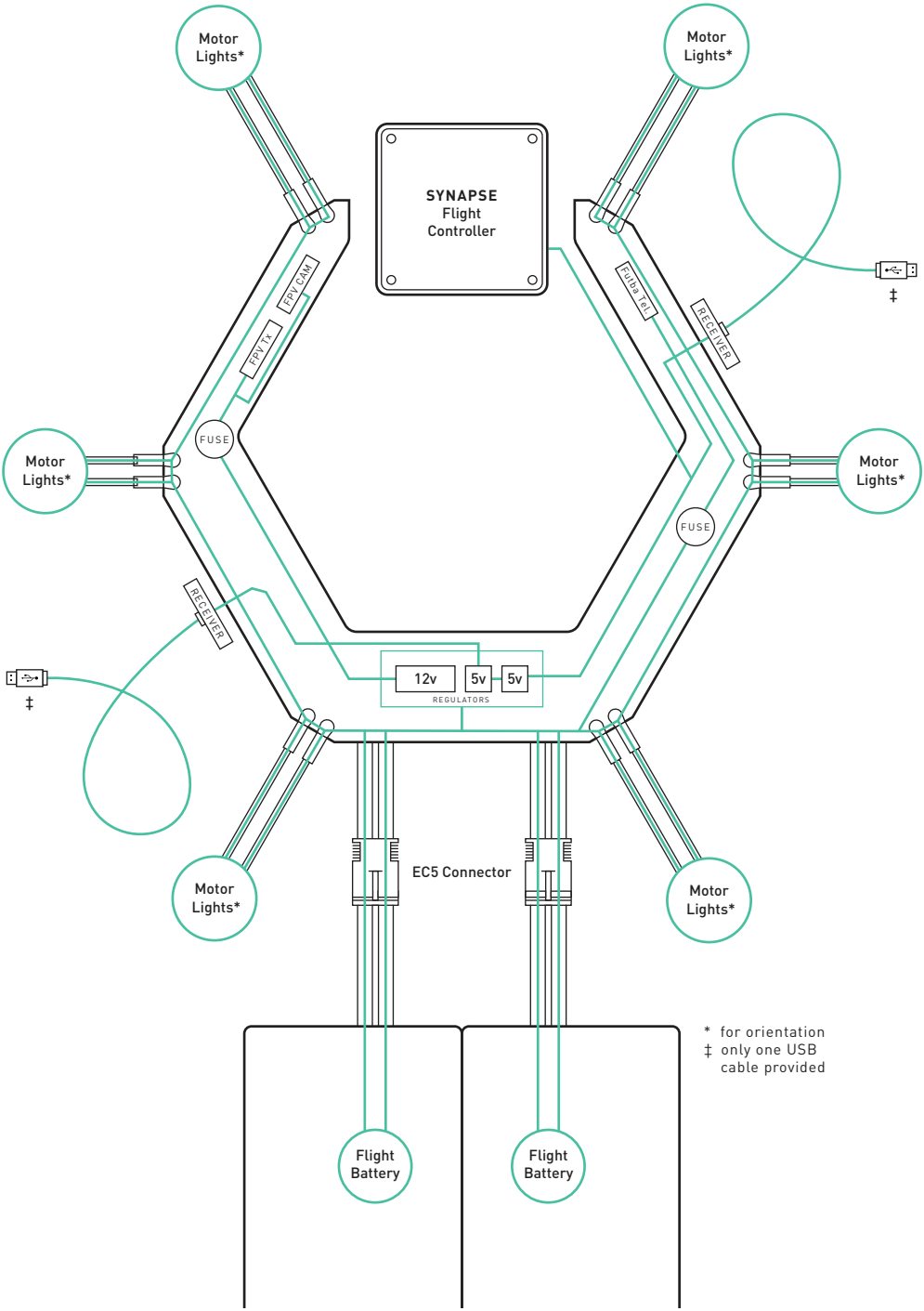
sUAS HIGH LEVEL



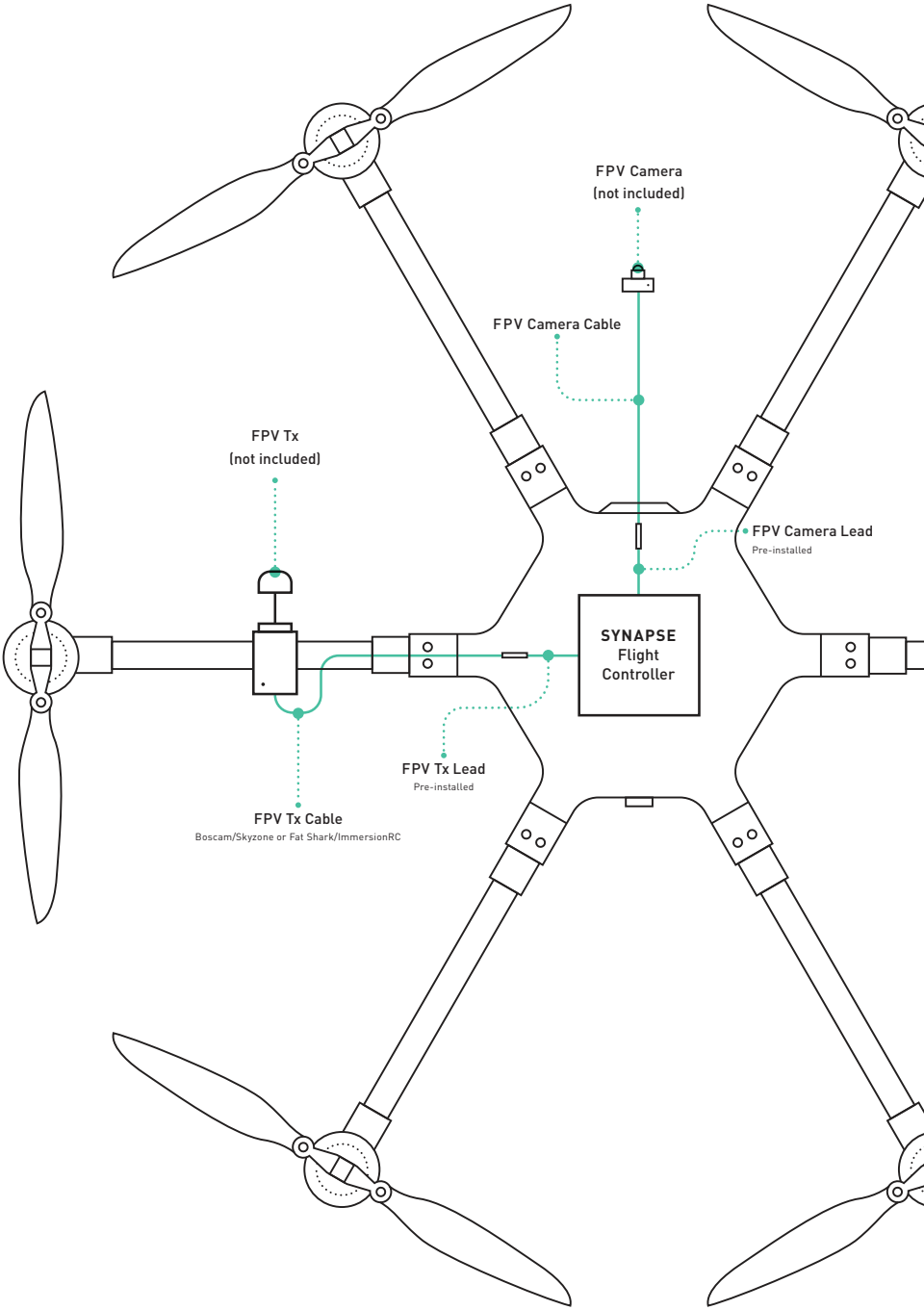
FLIGHT CONTROL



POWER SYSTEM



FPV EQUIPMENT



ALTA MOBILE APP

The ALTA App is used to configure ALTA parameters and to monitor ALTA's status during flight. To download the ALTA App, search for "Freefly ALTA" in the App Store or on Google Play™.

Parameters may only be adjusted while ALTA is on the ground and disarmed. In addition, radio mapping parameters can only be adjusted when the Configuration Jumper is removed. For more information on radio mapping, see the Radio Mapping section of this manual.

When making configuration changes with the ALTA App, wait three seconds for the app to automatically save changes to ALTA before shutting off the app or the mobile device.

The ALTA App will be actively maintained, and additional functionality may be added over time. For information on individual app updates, refer to the App release notes.

ADDITIONAL REQUIRED COMPONENTS (NOT INCLUDED)

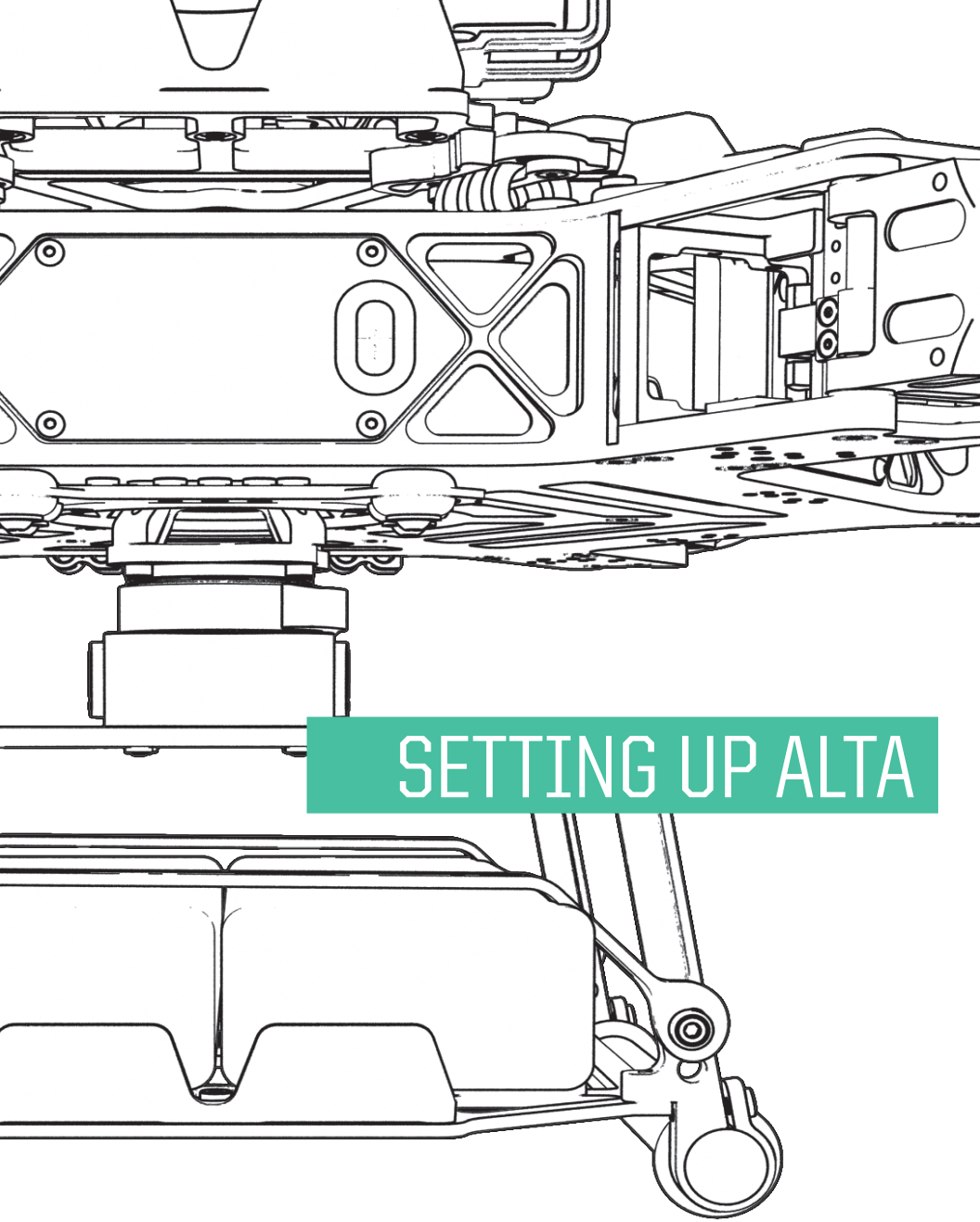
RADIO CONTROLLER

ALTA supports a variety of radio controllers as outlined in the Flight Controller Specifications. A minimum of five (5) channels are required, with four (4) used for flight control, and the remaining one (1) used for mode selection.

However, a radio controller with at least 9 channels is highly recommended to make use of Velocity and Climb Rate Clamps, Return-To-Home, and Arm Enable functions. It is recommended to use a radio controller with a three way switch for the Mode, Home and Arm Enable functions, and a knob or slider input for both the Velocity and Climb Rate Clamp functions.

FLIGHT BATTERY

ALTA can accommodate a variety of Lithium Polymer (LiPo) flight battery packs. Battery packs must be 6S, having a nominal voltage of 22.2 V. When running two packs, each pack must have a continuous discharge rating of 200 amps or greater, and a peak discharge rating of 400 amps or greater. When running a single pack, the pack must have a continuous discharge rating of 300 amps or greater, and a peak discharge rating of 600 amps or greater. For additional information on expected flight durations, refer to the Performance Section of the manual.



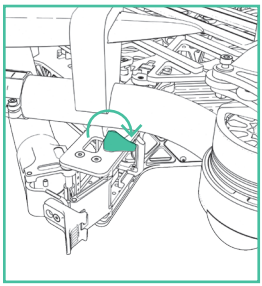
SETTING UP ALTA

UNFOLDING ALTA

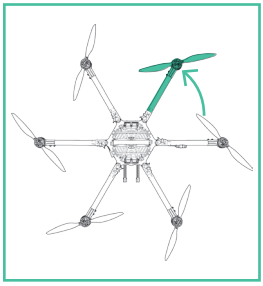
ALTA features swan-neck booms that fold into a compact size for travel. They are secured in an open position for flight using over-center latches.

TO UNFOLD ALTA

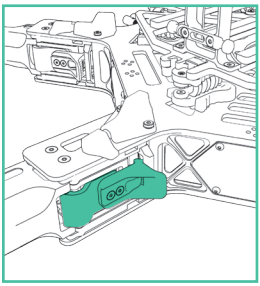
1. Remove ALTA from case
2. Fold down all six boom retention clips



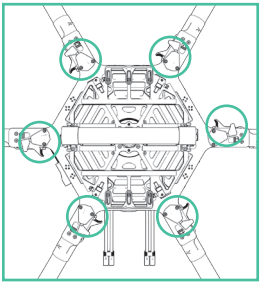
3. Open ALTA booms



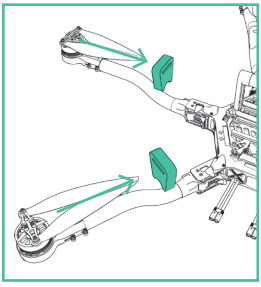
4. Snap shut all six boom latches until they “click”



5. Visually confirm all latches are seated properly

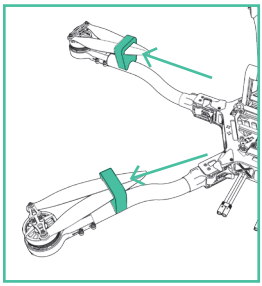


6. Remove prop protectors

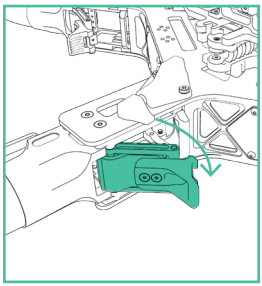


TO FOLD ALTA

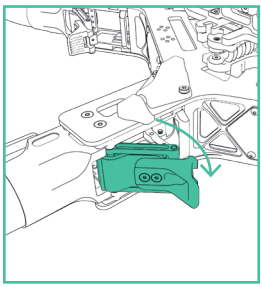
1. Secure props with prop protectors



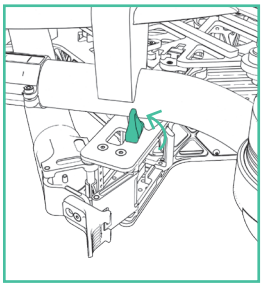
2. Unlatch all six booms



3. Close ALTA booms



4. Fold up all six boom retention clips to secure booms



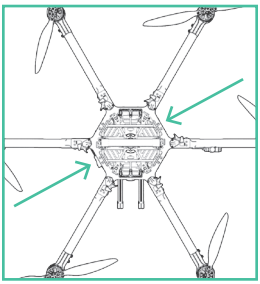
RADIO CONTROLLER RECEIVER

ALTA requires the installation of a radio control system. S.Bus, S.Bus2, DSM2, DSMX, and PPM (including inverted PPM and Graupner) receiver types are supported.

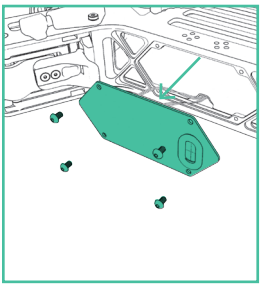
Additionally, ALTA supports radio receiver diversity using S.Bus, S.Bus2, DSM2 and DSMX receivers. This means two receivers may be installed, and the SYNAPSE flight controller will automatically use the receiver with the best signal quality. Using two receivers requires the radio controller to be bound to both receivers.

Refer to the instructions provided with your radio controller to complete the binding process. For Spektrum/JR radios, a receiver is required to bind the satellites to a radio controller.

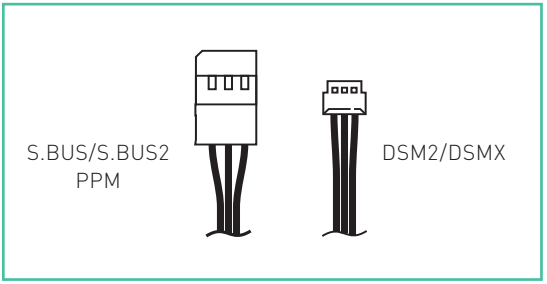
1. Locate the noted closeout panels used for receiver installation (between booms 1 & 2 and 5 & 6)



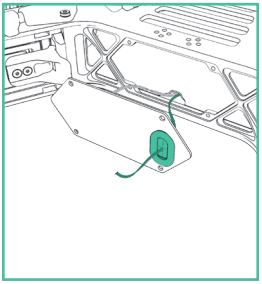
2. Remove side closeout panel with radio wires using a 1.5mm hex driver



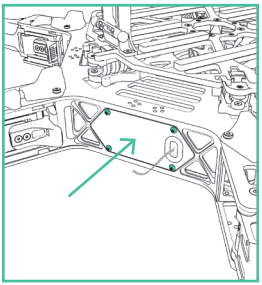
3. Identify required wire



4. Feed wire through grommet



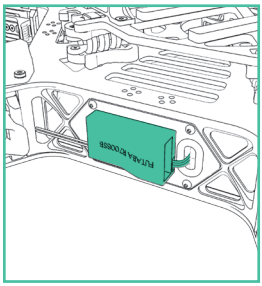
5. Replace side closeout panel



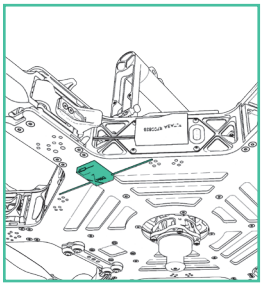
6. Plug in receiver/satellite to wire per the radio manufacturer's installation instructions

7. Attach receiver/satellite to exterior using the provided double sided tape

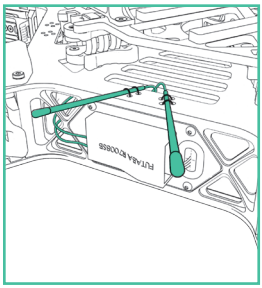
a. Futaba & PPM



b. Spektrum/JR



8. For Futaba receivers, feed antenna wires into antenna tubes and zip tie to noted mounting location



9. Repeat 1-7 on opposite side for dual receivers (only applies to Futaba and Spektrum/JR)

RECOMMENDED RECEIVER PLACEMENT

FUTABA

Mount Futaba receivers 15mm from the wiring grommet for easy S.Bus wire installation and removal (See Radio Controller Receiver step 7a).

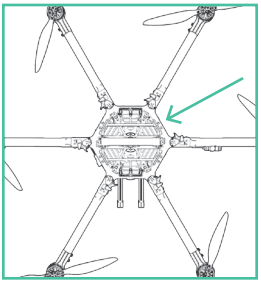
SPEKTRUM/JR SATELLITES

Mount satellites so antennae are blocked by the airframe as little as possible. If using two receivers, place them at a 90° angle to each other. (See Radio Controller Receiver 7b)

VOLTAGE TELEMETRY

ALTA supports battery voltage telemetry on Futaba radios using a receiver that supports an external voltage sensor, such as the R7008SB. To set up ALTA with voltage telemetry for Futaba radios:

1. Locate the radio receiver wire bundle behind the closeout panel between booms 1 and 2.

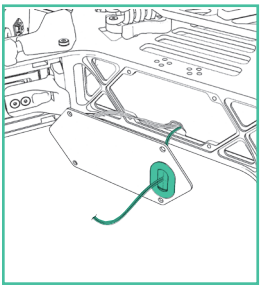


2. Identify the voltage sense wire and connector in the bundle. It is the small, 2-pin white connector attached to a black and red twisted wire pair.

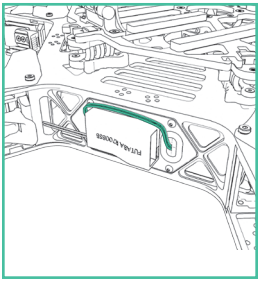
NOTE

This wire is already connected to an in-line fuse.
Soldering a fuse into this wire is not required.

3. Feed the voltage sense wires through the grommet on the closeout panel.



4. Connect the white connector to the external voltage sense port on the Futaba receiver.



ALTA can be used with a variety of radio controllers. Different radio controllers can map functions to different channels, so properly mapping controller channels to ALTA functions is an important step before flying. Radio mapping is performed using the ALTA App.

This section describes the steps required to complete radio mapping.

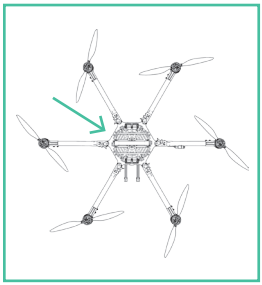
If you are uncertain about your channel mapping, obtain assistance from an experienced pilot or from Freefly Customer Support.

CONFIGURATION JUMPER

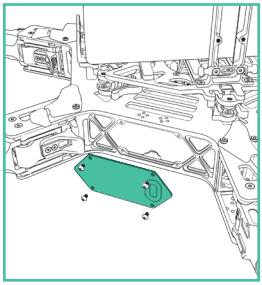
A small jumper is used to prevent motor operation while configuring radio mapping parameters. With the jumper in place, the motors may operate, but channel mapping is prevented. With the jumper removed, channel mapping may take place, but motor operation will be prevented.

To remove or replace the Configuration Jumper:

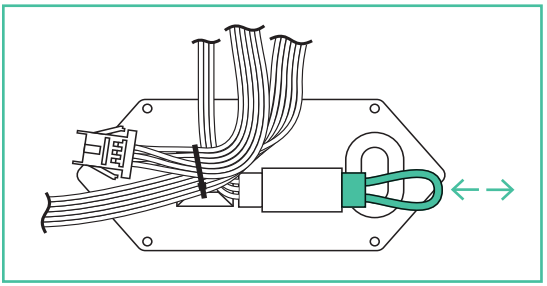
1. Locate the closeout panel where the jumper is installed



2. Remove the side closeout panel with the jumper using a 1.5mm hex driver



3. Remove or replace the jumper



4. Reattach the closeout panel

MAPPING RADIO CHANNELS USING ALTA APP

Channel mapping is accomplished with the ALTA App. Prior to mapping channels, ensure your radio controller and receivers are properly installed. Refer to the Radio Installation section of this manual and your Radio Controller's documentation.

1. Remove the Configuration Jumper

> ⚠ **WARNING**
>
> Always ensure the Configuration Jumper is removed prior to adjusting radio settings to prevent unintentional motor starts.

2. Power ALTA using a battery pack or by plugging in the included USB-Futaba cable into an available port on a Futaba receiver
3. Open the ALTA App and connect to ALTA
4. Open Configurations → Radio
5. Open each ALTA function and adjust the channel to the desired channel number, and use the toggle to invert the orientation of a control
6. Ensure proper channel selection by moving the control input on the radio controller and verifying the displayed graph in the ALTA App responds correctly

> ⚠ **WARNING**
>
> Ensure proper channel mapping prior to flight. Incorrect mapping can lead to immediate loss of control.

ONCE CHANNELS ARE MAPPED

7. Remove the battery or USB-Futaba cable from ALTA

8. Replace the Configuration Jumper

FUNCTION DESCRIPTIONS

The following functions can be mapped to radio controller channels. These are found in the Radio section of the Configurations menu in the ALTA App. Each function is also represented by a chart that responds to control input allowing for quick verification of mapping settings.

CONTROLLER

Use this to select the appropriate receiver. The following guide is compiled for convenience. For complete specifications and which mode will work with your receiver, refer to your radio controller or receiver manuals.

- » DSM2/DSMX are typically used by Spektrum and some JR controllers.
- » SBUS is typically used by Futaba controllers.
- » PPM is a generic standard used by many controllers and receivers.
- » PPM Invert is the same as PPM except channel inputs are reversed.
- » PPM Graupner interprets Graupner radio PPM inputs.

PITCH/ROLL/YAW/THROTTLE

The Pitch, Roll, Yaw and Throttle controls are the basic flight controls and are mapped to the two radio controller sticks.

MODE

The required Mode Switch selects between the three different flight modes: Manual, Height and Position. A three-position switch is recommended to select the three different modes. However, a two-position switch may be used, but will only allow for selecting between Manual Mode and (depending on radio controller mixes) either Position Mode or Height Mode

HOME SWITCH

The optional Home Switch selects between the different Return-To-Home (RTH) functions. A three-position switch is required for the Home Switch functions to select between the Home Set, RTH Off, and RTH Enable functions.

VELOCITY AND CLIMB RATE CLAMP

Velocity and Climb Rate Clamps set the maximum ground speed or vertical speed

available in Height Mode and Position Mode. The clamps can be adjusted mid-flight. An analog dial or slider is recommended for the Velocity and Climb Rate Clamp Functions.

ARM ENABLE

Arm Enable is an optional safety feature that inhibits arming while on the ground, or disarming while in the air based on the position of the switch. When not mapped, ALTA may be armed or disarmed at any time following normal arming and disarming procedures. See the Arm Enable Switch section of this manual under Operating ALTA for more information on switch behavior.

A minimum two-position switch is required to make use of Arm Enable. A three position switch may be used to temporarily turn off the feature as both arm and disarm are allowed in the switch's center position.

ALL FUNCTIONS

The meaning of the direction or position of the indicator is described in the following table for all mappable parameters. The top and right positions on the radio mapping indicators represent 2000µs, and the bottom and left positions represent 1000µs, and the middle position represents 1500µs.

FUNCTION	IN-APP INDICATOR POSITION	INDICATES
Pitch	Top	Nose Up
	Bottom	Nose Down
Roll	Left	Roll Left
	Right	Roll Right
Yaw	Left	Nose Left
	Right	Nose Right
Throttle	Top	High Throttle
	Bottom	Low Throttle
Mode	Top	Position
	Middle	Height
	Bottom	Manual
Home	Top	Set New Home Position
	Middle	RTH Off
	Bottom	Initiate RTH
Velocity Clamp	Top	Fast
	Bottom	Slow

Climb Rate Clamp	Top	Fast
	Bottom	Slow
Arm Enable Switch	Top	Arm Enable / Disarm Disable
	Middle	Arm Enable / Disarm Enable
	Bottom	Arm Disable / Disarm Enable

TYPICAL CHANNEL MAPPINGS

The following are channel mapping configurations as set in the ALTA App. These are recommendations only. Depending on exact radio models, these may help as an initial configuration. However, it is up to the pilot setting up ALTA for flight to determine if these settings are appropriate.

FUTABA 14SG/8FG

FUNCTION	CHANNEL NUMBER	DIRECTION
Pitch	2	Normal
Roll	1	Normal
Yaw	4	Normal
Throttle	3	Reverse
Mode	5	Normal
Home Switch	6	Reverse
Arm Enable	9	Reverse
Velocity Clamp	8	Reverse
Climb Rate Clamp	7	Reverse

SPEKTRUM DX18

FUNCTION	CHANNEL NUMBER	DIRECTION
Pitch	3	Reverse
Roll	2	Reverse
Yaw	4	Reverse
Throttle	1	Normal
Mode	6	Reverse
Home Switch	7	Reverse
Arm Enable	8	Normal
Velocity Clamp	10	Normal
Climb Rate Clamp	11	Normal

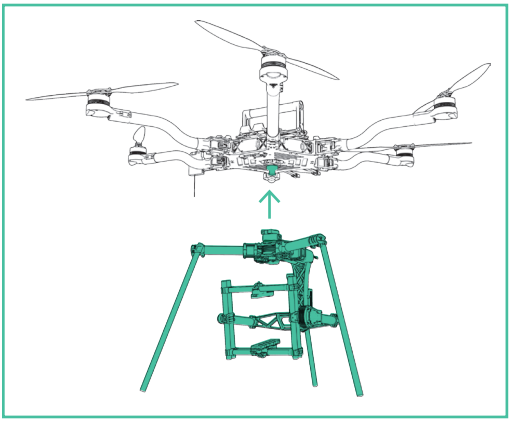
CONFIGURING TOP OR BOTTOM MOUNT

A MōVI can be attached to either the top or bottom of ALTA via the Freefly Toad In The Hole (TITH) quick release.

ALTA comes pre-configured for bottom mounting a MōVI.

BOTTOM MOUNT

1. Prepare your MōVI for bottom-mount flight (see MōVI manual)
   - **a.** Attach landing gear
   - **b.** Install TITH receiver on MōVI
2. Connect MōVI to bottom Toad

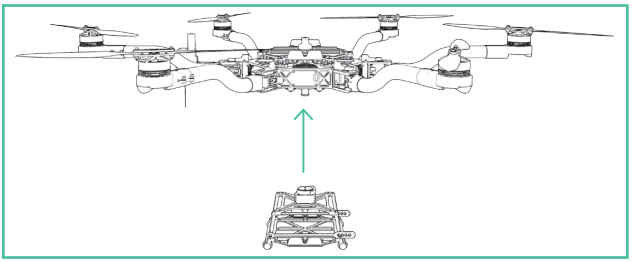


ADDING A TITH TOP MOUNT

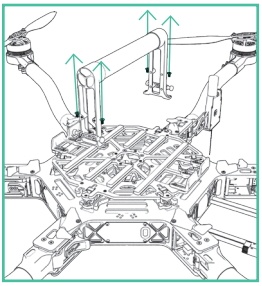
> **CAUTION**
>
> Top mounting is not supported by the MōVI M10.

1. Prepare your MōVI for top-mount flight
   - **a.** Remove landing gear (see MōVI manual)
   - **b.** Install TITH receiver on MōVI (see MōVI manual)

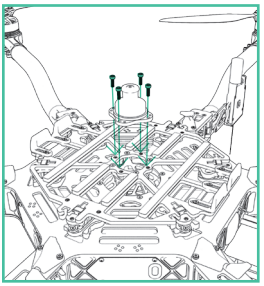
2. Connect and secure the supplied inverted landing gear to the bottom Toad



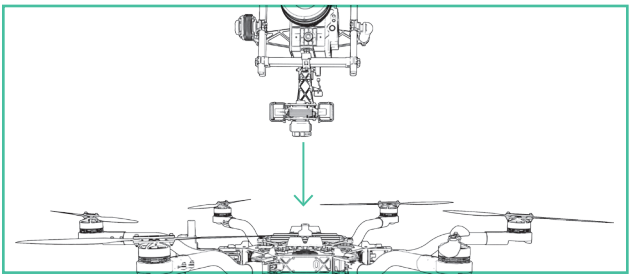
3. Remove the four flat-head M3×6 bolts that secure the top handle



4. Attach the supplied Toad to the top plate using the four M3×8 bolts provided

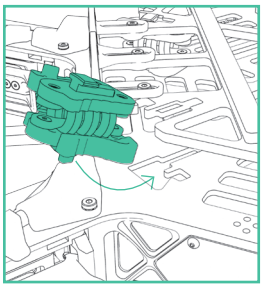


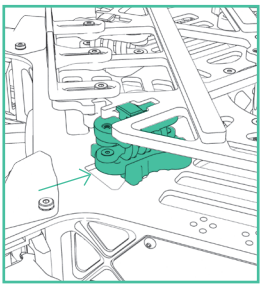
5. Connect MōVI to the top Toad



ISOLATOR CARTRIDGES

Different Isolator Cartridges can be used to fine tune vibration damping performance for different payload weights. Three isolation cartridge styles are provided with ALTA with the red for light payloads, teal for medium payloads, and black for heavy payloads. Flight testing may be required to determine the optimal isolator for a given setup.

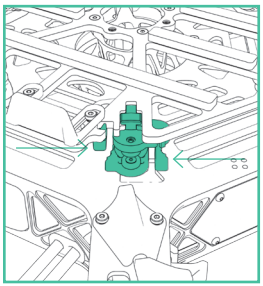


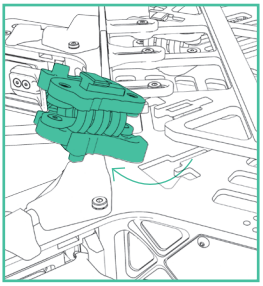


To install, place the cartridges between the top chassis plate and the battery plate. Ensure they are engaged in the track features and are parallel with the chassis and battery plate. Push inwards fully until they click, indicating the cartridges are locked in place. Pull outwards on the cartridge to ensure it is locked in place.

⚠ CAUTION

Always ensure isolator cartridges are locked in place before flying ALTA. Isolator cartridges that are not locked can cause the payload to loosen and change ALTA's fundamental flying characteristics.





To remove, pinch the cartridge latch to unlock it from the battery and chassis plate. Simultaneously pull the battery and chassis plate apart while pulling the cartridge outward.

BATTERY INSTALLATION

Batteries may be installed on either the top or bottom of an ALTA and are always mounted opposite of the payload location. In both locations, battery pack(s) are secured with silicone straps tensioned across the pack(s). The straps are secured using studs located on either side of the pack(s).

⚠ WARNING

Always secure battery pack(s) with both battery retention straps.

ⓘ CAUTION

When installing two battery packs, ensure they are at a similar state of charge (a full pack voltage difference less than 0.5V). Plugging in two dissimilarly charged packs could cause one pack to rapidly discharge into the other and damage the batteries or cause a battery fire.

ⓘ CAUTION

When using two battery packs, only use packs that are identical in their capacity and at a similar condition. Using a pack with another that is larger, or has many more cycles, can damage the battery packs.

ⓘ CAUTION

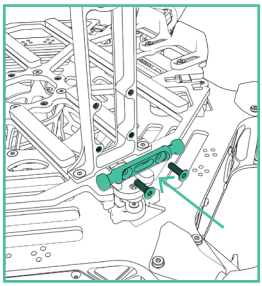
Always refer to and follow the battery manufacturer's instructions, recommendations and guidelines for battery handling.

ⓘ CAUTION

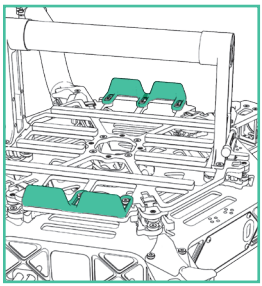
When plugging in battery pack(s), ensure the polarity is correct. Positive is indicated by a red power lead, and negative/ground is indicated by a black power lead. Reversing polarity will damage ALTA's electronics.

BOTTOM MOUNT

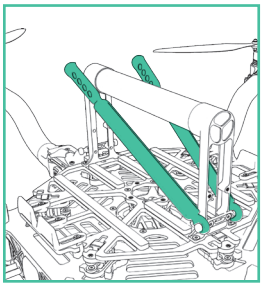
1. Place battery retention strap studs at the appropriate height for battery pack(s)



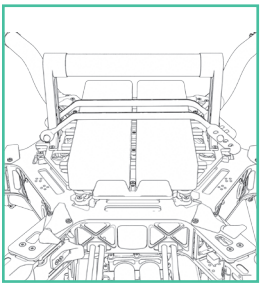
2. Adjust battery stops to fit battery pack(s)



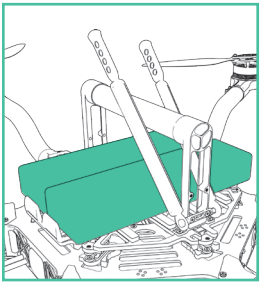
3. Attach the single-hole end of the battery retention straps to the studs



4. Place battery pack(s) on battery tray below handle



5. Tension and secure battery retention straps

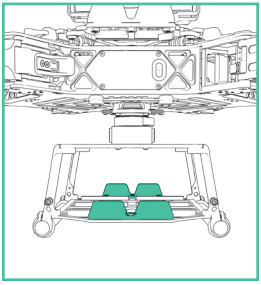


TOP MOUNT

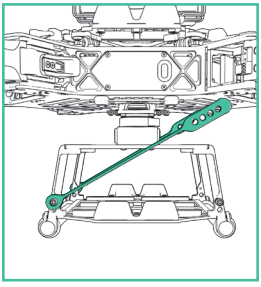
⚠ CAUTION

Always completely secure the inverted landing gear by closing the TITH quick release lever. Inverted landing gear that are not completely attached can rotate and unplug battery leads.

1. Adjust battery stops to fit battery pack(s)

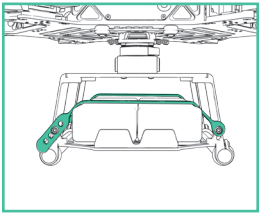


2. Attach the single-hole end of the battery retention strap to a stud on the landing gear



3. Place battery packs(s) in landing gear

4. Tension and secure battery retention straps



COMPASS CALIBRATION

For best results, it is recommended to perform manual compass calibrations away from ferrous objects, buildings and vehicles. In addition, concrete can contain steel rebar which may influence compass calibrations.

⚠ WARNING

Verify ALTA is disarmed prior to performing a compass calibration. To ensure ALTA does not arm, set the Arm Enable Switch (if available) to disable, and remove the Configuration Jumper.

NOTE

It is recommended to use two people to perform the compass calibration as it requires handling and rotating ALTA. Perform calibration without a payload attached.

NOTE

Ensure a microSD card is installed in the GPS/compass module prior to performing compass calibration.

TO PERFORM A COMPASS CALIBRATION:

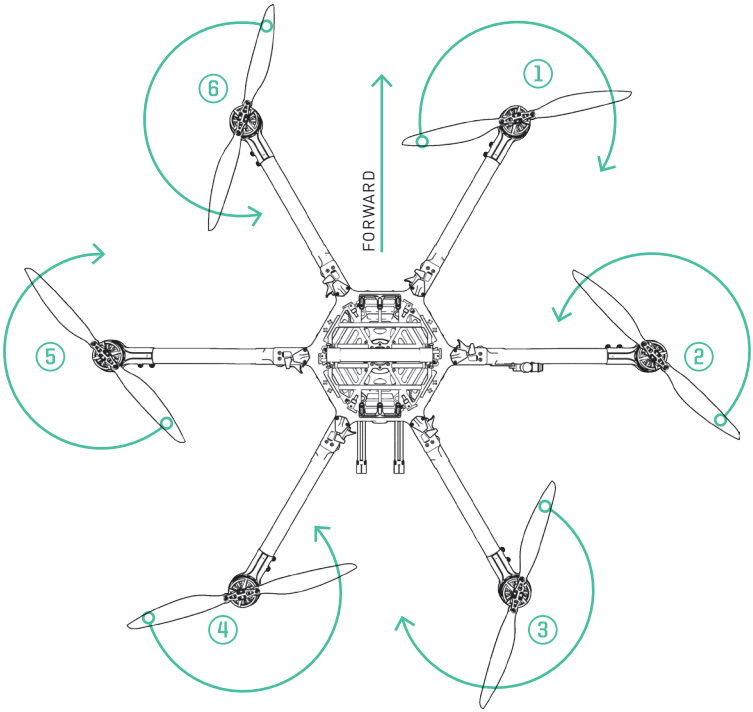
1. Secure a battery onto ALTA
2. Plug in the battery
3. Open the ALTA app
4. Select Configurations → More → Compass
5. Under Calibration, select Start Manual
6. Follow the on-screen instructions

AUTOMATIC COMPASS CALIBRATION

Automatic Compass Calibration will use compass readings over time to resolve an accurate compass calibration. Manual calibration is recommended for more immediate results thus enabling better closed loop, GPS assisted flying.

In the ALTA App, select Configurations → More → Compass. Change the Auto Calibration setting to On.

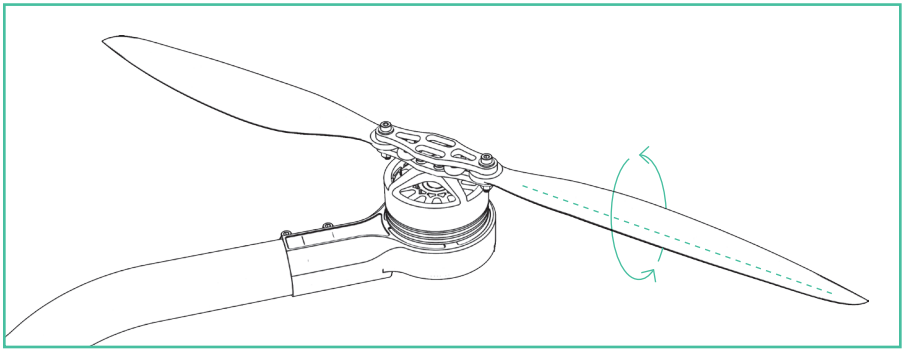
PROPELLERS



The folding propellers include two carbon fiber propeller blades attached to prop hubs, which are themselves secured to the motors. The propellers installed on booms 1, 3 and 5 spin clockwise when viewed from above ALTA, and the propellers installed on booms 2, 4 and 6 spin counterclockwise when viewed from above.

For information on propeller installation and maintenance, refer to the Maintenance section of this manual.

CHECKING PROP BOLT TIGHTNESS



Over time, the bolts that hold the propeller blades to the prop hub can loosen due to vibration. To check prop bolt tightness, twist the prop about its length. If there is free play, the prop bolt is too loose. Use the provided 2.5mm hex driver and wrench to tighten the bolt and nut that secure the prop blade just enough to remove the play.

⚠ CAUTION

Do not overtighten, or the prop may fail to unfold completely during motor start up, leading to excessive vibration.

FIRST PERSON VIEW (FPV)

ALTA and SYNAPSE can power a variety of first person view (FPV) cameras and transmitters, as well as add informational on-screen display (OSD) elements to aid in FPV flying.

Two FPV transmitter cables are included. The cable with two connectors on one of the ends will run ImmersionRC and Fat Shark systems, and the cable with a single connector on the end will run Boscam and SkyZone systems.

A single camera cable is provided, and is configured to run a Ready Made RC camera.

Camera and transmitter cables follow this wiring scheme:

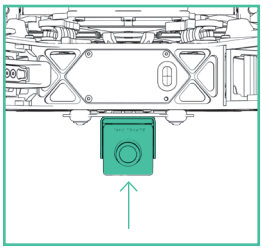
CABLE COLOR	FUNCTION
Red	+12 VDC
Black	Ground
Yellow	Video signal

> ⚠ **WARNING**
>
> It is the responsibility of the pilot to see and avoid other aircraft, people or obstacles. Always maintain direct line of sight with ALTA during flight, use visual observers as operations require, and follow local regulations regarding see-and-avoid requirements.

FPV SYSTEM INSTALLATION

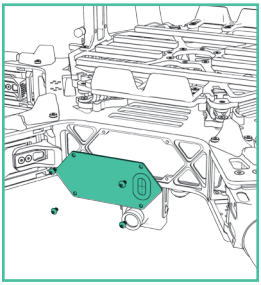
CAMERA

1. Mount FPV camera on the FPV mount on the front underside of ALTA or other preferred location.

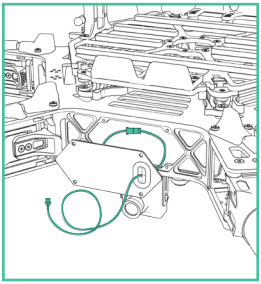


2. Locate the FPV camera cable included in the ALTA package.

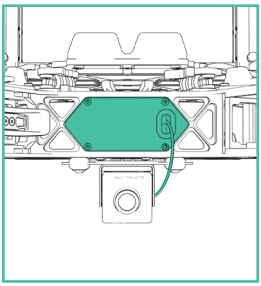
3. Remove the front closeout panel with a 1.5 mm hex driver.



4. Pass the FPV cable through the grommet, and connect to the mating FPV camera lead inside ALTA. Connect the other end directly to the camera.

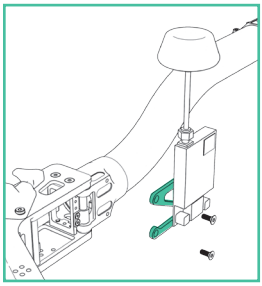


5. Replace front closeout panel.

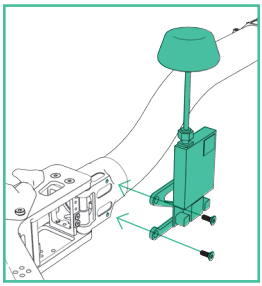


TRANSMITTER

1. Mount FPV transmitter on the provided carbon fiber accessory mount plate.



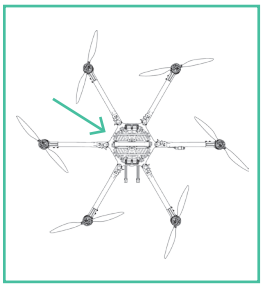
2. Attach Accessory Mount to boom 5 with M3×8 flathead bolts.



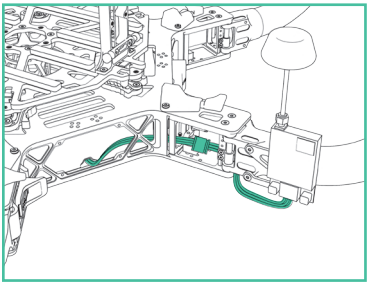
3. Locate the appropriate FPV transmitter cable. The following cables are included:

- **a.** ImmersionRC/Fat Shark (cable with two connectors)
- **b.** Boscam/SkyZone (cable with one connector)

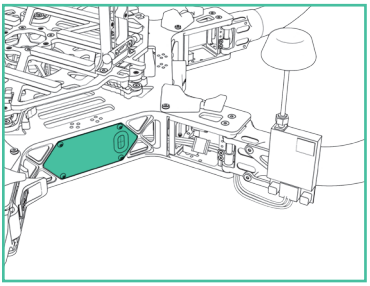
4. Remove the side closeout panel with the FPV transmitter lead using the 1.5mm hex driver.



5. Pass transmitter cable through the underside of the hinge, and connect to the FPV transmitter lead.



6. Replace side closeout panel.



7. Zip tie the FPV transmitter lead to the boom cable bundle for strain relief.

FPV ON SCREEN DISPLAY SETUP

A number of properties and components can be adjusted or added to the FPV On Screen Display (OSD) using the ALTA App.

PROPERTIES

NAME	OPTIONS	DESCRIPTION
Video Mode	PAL / NTSC	Indicates to the SYNAPSE the FPV video camera format
Units	SI / Imperial	Changes the displayed units
Horizontal Offset	0, 15, 30, 45, 60	Centers the OSD components horizontally
Vertical Offset	0, 8, 16, 24, 30	Centers the OSD components vertically
Borders	0, 1, 2, 3	Adds gaps between OSD components and the edges of the display, measured in character widths and heights

TEXT COMPONENTS

The following components are displayed as text items, and can be configured to display as big or small letters, or no letters effectively turning off the display.

NAME	DESCRIPTION
Height	Displays the height of ALTA from its starting point in meters or feet
Vario	Displays the vertical speed of ALTA in meters per second or feet per minute
Heading	Displays the magnetic heading of ALTA and is measured in degrees
Distance	Displays the distance ALTA is from the home position in meters or feet
Ground Speed	Displays the ground speed of ALTA in meters per second or knots
Battery	Displays the voltage of the flight battery pack
Time	Displays the time of the flight in minutes and seconds
GPS	Displays the number of GPS satellites in view
GPS Accuracy	Displays the horizontal accuracy of the GPS signal in meters or feet
Lat/Long	Displays the GPS derived latitude and longitude coordinates of ALTA

ARTIFICIAL HORIZON COMPONENTS

The artificial horizon displays pitch and roll information in the center of the FPV display in the form of a horizon line and accompanying elements.

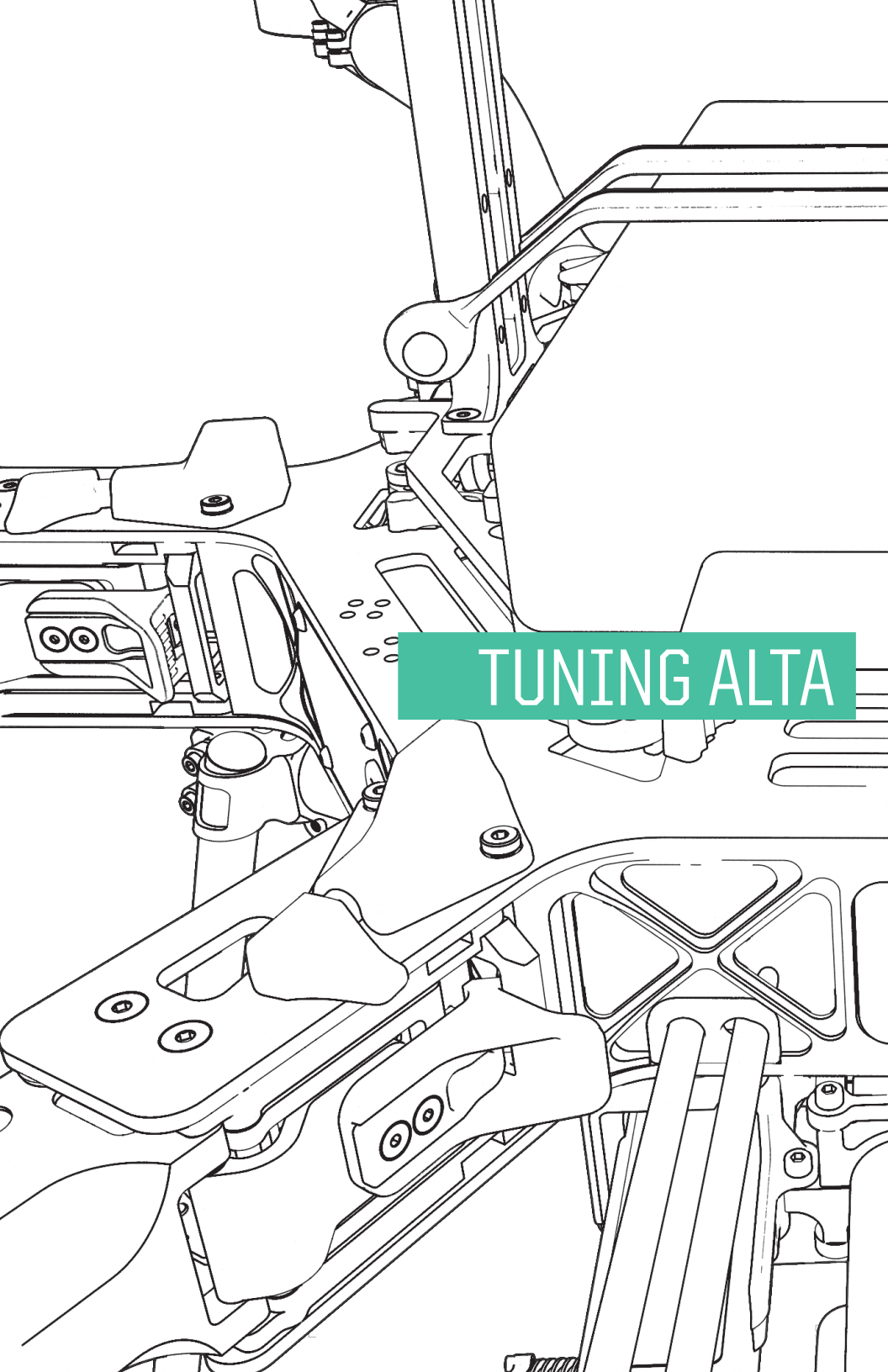
NAME	OPTIONS	DESCRIPTION
Artificial Horizon	No	Turns off all artificial horizon components
	Basic	Adds a horizon line that moves up and down as ALTA changes pitch, and rolls as ALTA rolls
	Ladder	Adds pitch marks at intervals defined by the Pitch Interval setting

Roll Marker	Basic	Adds small dash marks on the left and right side of the artificial horizon that indicate changes in roll
	Horizon	Adds marks to include a full horizon line
	Ladder	Adds small marks on either side of the artificial horizon ladder that roll with ALTA roll movements
Pitch and Roll Scaling	10, 20, 30, 40	Allows for scaling of the artificial horizon markings to compensate for FPV cameras of different field views
Pitch and Intervals	10, 20, 30, 40	Sets the number of degrees between pitch markings when the artificial horizon ladder is used

OTHER COMPONENTS

The following components can be turned on or off. There are no other options associated with these components.

NAME	DESCRIPTION
Compass Arrow	Displays an arrow that points in the direction of north
Home Arrow	Displays an arrow that points in the direction of the home point
Vario Bar	Displays a bar on the right of the screen that scales with vertical speed. The bar will increase in length up to indicate a climb, or down to indicate a descent
Forward Velocity	Displays a bar on the left of the screen that scales with the forward/rearward velocity component The bar will extend up to indicate forward velocity, or down to indicate a rearward velocity
Sideslip	Displays a bar on the bottom of the screen that scales with the side-to-side velocity component The bar will extend left to indicate leftward velocity, or right to indicate rightward velocity



TUNING ALTA

ALTA comes pre-tuned for a wide variety of payloads and flying conditions. Generally, additional tuning is not required to fly ALTA, and additional tuning will only need to take place if more customization of control feel is desired. Default tuning values are included in Appendix A, Default Tuning Values.

Parameters fall into three categories - Attitude, Height and Position. Typically, tuning should take place in that order, ensuring Attitude parameters are set first, then moving to Height parameters, and finally Position parameters.

Tuning should take place as an iterative process by making only small changes, test flying the changes, observing the new flight behaviors, and repeating. Only tune a single parameter at a time during this process for best results.

To tune ALTA, open the ALTA App and select Configurations → Aircraft Dynamics.

⚠ WARNING

Tuning can change the fundamental flying characteristics of ALTA. It is possible for ALTA to become unstable or even uncontrollable if values are set too high or too low. Only change tuning parameters in small increments and with caution. Always test new tuning configurations in open areas away from people or obstacles.

NOTE

The ALTA App only allows tuning while ALTA is on the ground.

ATTITUDE TUNING

Attitude tuning adjusts how ATLA responds to control inputs and disturbances. Attitude directly controls responsiveness and changes ALTA's fundamental flying behaviors. Attitude must be tuned acceptably before tuning height or position parameters.

When tuning attitude, the primary parameter to change is Stiffness followed by Strength.

STIFFNESS

Stiffness is adjusted for pitch and roll simultaneously, and yaw independently. It changes how stable ALTA is in these axes and is the primary variable to adjust when

tuning. When tuning Stiffness first, or making large stiffness changes, Hold Strength should be set to a low, non-zero value.

Higher Stiffness values give more responsive control. Values that are too high can cause instability or oscillation.

> ⚠ **WARNING**
>
> Excessively high stiffness values can cause ALTA to become unstable and difficult or even impossible to control.
>
> Lower Stiffness values give less responsive control. Values that are too low can cause a vague or disconnected control response.

HOLD STRENGTH

Hold Strength controls how much ALTA will try to maintain a pitch/roll angle command, or a yaw heading command. It is adjusted for pitch and roll simultaneously, and yaw independently. A higher Hold Strength setting will give a faster control response and a more responsive feel. However, values that are too high can cause ALTA to overshoot pitch or roll commands, or even cause instability.

> ⚠ **WARNING**
>
> Excessively high strength values case cause ALTA to become unstable and difficult or even impossible to control.
>
> Typically, this setting will not need to be changed from the default value, and only then in small increments.

HEIGHT TUNING

Tuning height parameters will adjust the control feel of ALTA's height control while in Height and Position modes (for additional information on flight modes, see the Flight Controller Modes section of this manual). Tune height parameters only after satisfactorily tuning attitude parameters.

Similar to attitude tuning, stiffness is the primary tuning parameter.

If switching to Height Mode causes ALTA to fly in an unstable manner, switch back to Manual Mode, land and try reducing the values of height tuning gains if they are very high, or increasing them if they are very low.

VERTICAL STIFFNESS

Vertical Stiffness Gain modifies the vertical stability of the ALTA in Height mode.

Decrease this value if ALTA experiences vertical oscillation or vibration. Increase this value if ALTA is sluggish while accelerating to a desired climb or descent rate in Height mode.

HOLD STRENGTH

Hold Strength Gain tunes how much ALTA will attempt to stay on a desired altitude in Height Hold mode only. A higher value will result in height being held more precisely. Too high of a value can cause ALTA to overreact to winds, gusts or turbulent air.

CLIMB RATE STRENGTH

Climb Rate Strength adjusts how much ALTA will attempt to maintain a desired climb rate. Higher values will result in a more direct feel between pilot climb or descent commands and ALTA flying behavior. However, values that are too high may cause instability.

POSITION TUNING

Tuning position parameters will adjust how well ALTA maintains a desired ground speed or a position over the ground. Similar to attitude and height tuning, the primary value to adjust is stiffness.

HORIZONTAL STIFFNESS GAIN

This changes the horizontal stability of ALTA. Higher values increase ALTA's resistance to wind gusts or turbulence from moving ALTA off its target position. Values that are too high can cause instability of ALTA.

HOLD STRENGTH GAIN

This adjusts how much ALTA will attempt to maintain its place over a target position. A higher value will result in position being held more precisely. If too high, positional instability can result, causing ALTA to fly past a target position.

Flight Parameters are different from tuning parameters in that the flight characteristics of ALTA will not change with their modification. However, they can be used to select neutral points using trim, or to set maximum or minimum values.

ATTITUDE

PITCH AND ROLL TRIM

Use Pitch and Roll trim settings to correct for tendencies of the ALTA to pitch or roll with a neutral control input.

Use the in-app pitch and roll trim settings instead of radio controller trim features as large radio controller trims could prevent position hold from engaging at neutral stick positions.

MAXIMUM PITCH/ROLL ANGLE

This sets the maximum angle the ALTA will be allowed to fly in all modes and in all flight conditions.

MAXIMUM YAW RATE

This is the maximum rate the ALTA will yaw (pan) when at full stick deflection.

HEIGHT

HOVER THROTTLE

Hover Throttle is a parameter that adjusts ALTA's thrust at center throttle stick, and ensures ALTA does not climb or descend at the center stick position while flying in Manual Mode. A Hover Throttle setting that is too high or too low can cause ALTA to climb or descend when switching between Manual and Height Modes.

NOTE

Hover Throttle will need to be adjusted when changing the overall weight of the system, or when moving between very different elevations.

Adjust the Hover Throttle setting such that during a stable hover the required throttle position is at middle stick, or about 1500 µs in the App radio chart. Increase Hover Throttle if hover occurs above center stick, and decrease if hover occurs

below center stick.

Alternatively, if ALTA climbs when switching from Manual to Height mode, increase hover throttle, since a climb indicates a stick position that is higher than neutral in Manual mode. If ALTA descends, decrease hover throttle, since a descent indicates a stick position that is lower than neutral in Manual mode.

> **NOTE**
>
> The ALTA App does not allow hover throttle adjustments while ALTA is flying.

MAXIMUM CEILING

This adjusts the highest altitude the ALTA is allowed to climb from its starting point while in Height or Position modes. If the maximum ceiling is exceeded in Manual mode, the Status Light will illuminate white.

MAXIMUM CLIMB RATE

This sets the maximum speed ALTA will climb at full throttle stick deflection in Height Mode or Position Mode

If Climb Rate Clamp is mapped to an radio controller channel, the parameter will adjust the fastest climb speed available to the Climb Rate Clamp feature.

GPS HEIGHT CORRECTION

With GPS Height Correction On, SYNAPSE will use both barometer and GPS sensor measurements to determine its altitude. It can be useful for assisting in windy or gusty conditions, but requires good GPS reception. It is recommended to keep this enabled unless GPS reception is problematic.

POSITION

MAXIMUM G

This sets the total maximum acceleration, in G's, that the controller will place on the airframe. It is recommended to use lower G settings with heavier payloads.

This setting has no effect in Manual mode.

MAXIMUM GPS ANGLE

This sets the maximum pitch and roll angle the ALTA may fly under Position mode. This will not override the Attitude Maximum Pitch/Roll Angle. Instead, ALTA will

follow the lower of these two limits.

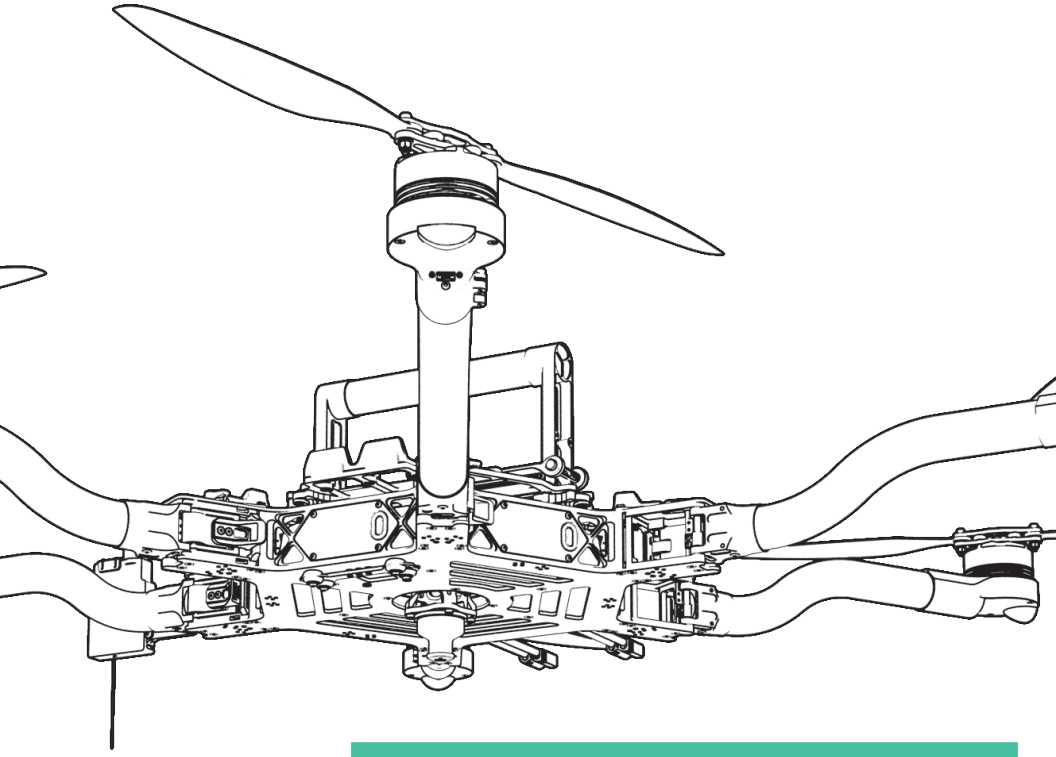
MAXIMUM GPS SPEED

Max GPS Speed sets the maximum speed ALTA will fly across the ground at full stick deflection in Position Mode.

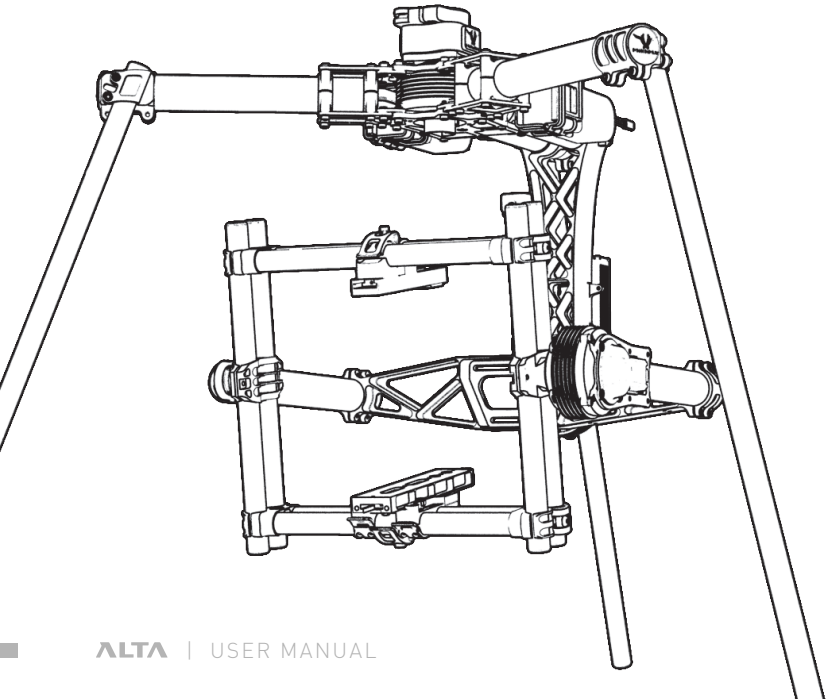
If Velocity Clamp is mapped to an RC transmitter channel, the parameter will adjust the fastest ground speed available to the Velocity Clamp feature.

RANGE

Range sets the maximum distance ALTA may fly away from the home point while in Position mode. If the range is exceeded in Manual mode, the status light will illuminate white.



OPERATING ALTA



ALTA has three primary flight control modes: Manual Mode, Height Mode, and Position Mode. They are selected with the Mode Switch

CAUTION

Always neutralize control inputs when switching between control modes.

MANUAL MODE

In Manual Mode, ALTA will only stabilize its attitude. At neutral control input (middle pitch and roll stick position), ALTA will attempt to remain level. Throttle control is direct.

HEIGHT MODE

Height Mode changes the throttle stick behavior to command climb and descent rates. The higher the throttle stick position, the faster ALTA will climb. Conversely, the lower the throttle stick position, the faster ALTA will descend.

When the throttle stick is centered, ALTA will enter Height Hold. In Height Hold, ALTA will maintain a target altitude and try to correct for drift. If a disturbance moves ALTA away from this target altitude, ALTA will climb or descend to return to the target altitude.

POSITION MODE

Position Mode changes the pitch/roll stick behavior to command ground speeds. Pitch and roll stick deflection will command fore/ aft and left/right ground speeds respectively. Controlling altitude in Position Mode is the same as in Height Mode.

With pitch and roll controls centered, ALTA will enter Position Hold. In Position Hold, ALTA will maintain its position over a given point on the ground and correct for disturbances.

Position Mode requires a strong GPS signal. If a weak signal is present, ALTA will not enter Position Mode, and if the GPS signal degrades while in Position Mode, ALTA will automatically revert to Manual Mode.

ⓘ CAUTION

Flight using Position Mode in areas of degraded GPS signal, such as near buildings or under dense tree cover, is not recommended. The automatic reversion to Manual Mode can cause unexpected, abrupt changes in flight behavior.

RETURN-TO-HOME

Return-To-Home Mode will command ALTA to fly back to the starting point of the flight or the last defined Home Point. When ALTA first acquires a GPS position, it sets this as the Home Point of the flight. The Home Switch on your radio controller can also be used to set a new Home Point. See the Radio Mapping section in this manual for more information on setting up the Home Switch.

RTH can be initiated manually by the Home Switch or be initiated with an LOS event.

When initiated with the Home Switch, ALTA will fly back to the Home Point, and the pilot will maintain control of ALTA's altitude the entire time. ALTA will not Autoland if an adequate signal is detected. The pilot can cancel the RTH procedure by commanding a pitch or roll command or by retuning the Home Switch to the middle position. The Mode Switch must be in Position Mode to activate RTH manually.

During an LOS event, ALTA will first check its current altitude against Safe Height. If it is lower, it will climb to Safe Height, and if ALTA is above Safe Height, it will remain at its current altitude. Next, ALTA will fly back to the home position at the RTH Speed set in the ALTA App. Finally, upon reaching the home position, ALTA will begin Autoland.

AUTOLAND

The Autoland function will command ALTA to hover for 10 seconds and will then land in place. This only occurs if Autoland is selected as the Loss of Signal (LOS) event in the ALTA App, or at the end of an LOS Return-to-Home (RTH) event. If ALTA is above the app-configurable Safe Height setting, ALTA will first descend to the Safe Height at the Maximum Descent Rate. After reaching this height, ALTA's descent will slow to the Autoland Descent Rate until landing.

HOME SWITCH

The home switch has three settings, Set Home, RTH Off and RTH On.

SET HOME

Set Home sets a new home point at ALTA's current position. This could be useful for setting a point away from the initialization point, such as if the ALTA were started underneath an overhang or a tree.

A new home point can only be set within 20 meters of ALTA's starting point. Momentarily moving the Home Switch to the Set Home position sets a new home point. When a new home point is set, the Status Light will turn white to indicate the new home point was successfully set.

RTH OFF

This is the normal switch position and does not initiate an RTH command.

RTH ON

This manually initiates the RTH command. In a manual RTH, the pilot maintains control of height while the SYNAPSE will command ALTA's position over the ground to the home point.

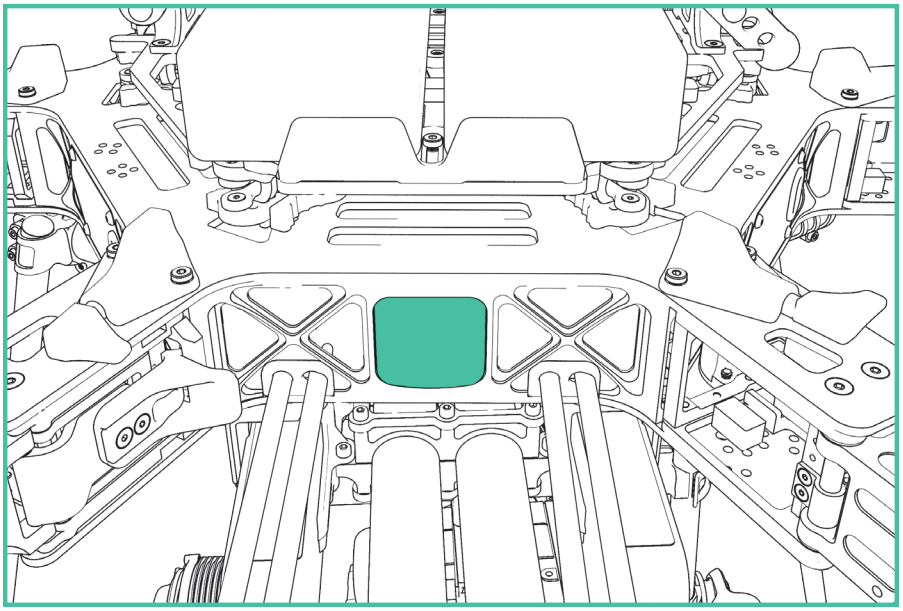
ARM ENABLE SWITCH

The optional Arm Enable Switch allows for added safety while working around and flying ALTA by disallowing arming during ground handling or disarming during flight. To set up an Arm Enable Switch, refer to Mapping Channels or the ALTA User Manual.

If used, the Arm Enable function should be mapped to a three-position switch.

SWITCH POSITION	ARMING	DISARMING
1	Possible	Not possible
2 (middle)	Possible	Possible
3	Not possible	Possible

STATUS LIGHT

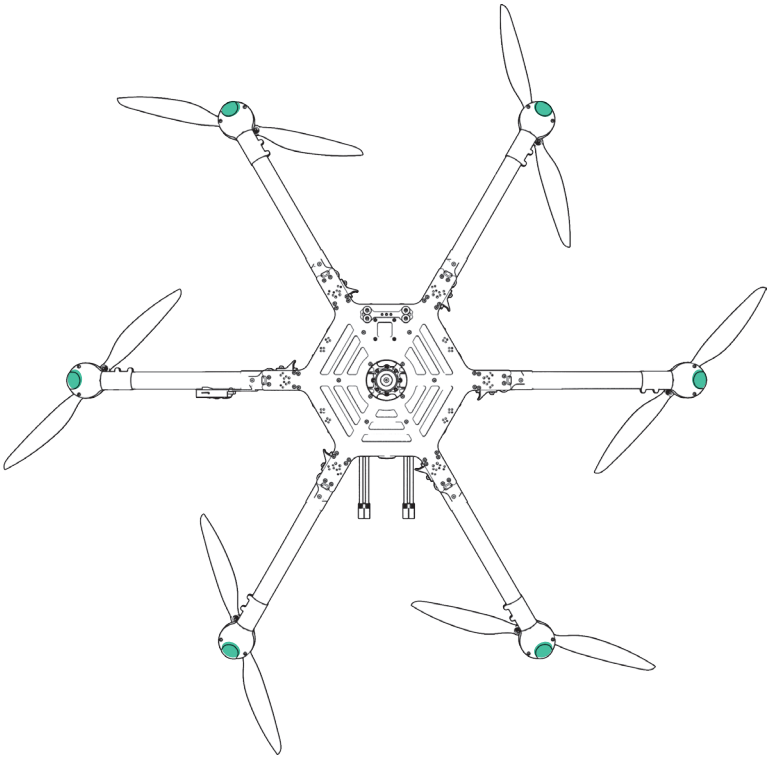


The rear-facing Status Light shows the status of ALTA as it boots, arms and flies. The following table shows the different meanings of the light in the various flight phases.

FLIGHT PHASE	LIGHT COLOR	MEANING
Booting	Flashing Red + White	Flight controller is booting
Standby	Flashing White	Flight controller is running and dis-armed
	Flashing Red	Flight controller is running and not ready to arm
	Solid Red	Flight controller boot unsuccessful
Armed	Off	Ready for Flight
Flight - all modes	Solid Red	A flight controller error has occurred or Battery cell voltage below user-defined levels

Flight - Manual Mode	Off	Nominal flight status No errors
	Solid White	Outside user-defined range, height or speed limits
Flight - Height Hold	Off	Nominal flight status Height hold inactive
	Slow Flashing White	Height hold active
	Flashing Red	Battery cell voltage below user-defined levels
Flight - Position Hold	Off	Nominal flight status Height hold inactive Position hold inactive
	Slow Flashing White	Height Hold or Position Hold Active
	Fast Flashing White	Height Hold and Position Hold Active
	Flashing Red	Battery cell voltage below user-defined levels

ORIENTATION LIGHTS



BOTTOM VIEW

The boom-end mounted Orientation Lights indicate both the orientation of ALTA in flight and the status of the individual motor Electronic Speed Controllers (ESCs) during other flight phases. The following table shows the different meanings of the light colors in the various flight phases.

FLIGHT PHASE	LIGHT COLOR	MEANING
Booting	Blue	ESC booting
Standby	Flashing Green	ESC booted normally
Armed	User-defined	Nominal Status
Flight	User-defined	Nominal Status
Firmware Update	Blue then Yellow	ESC firmware is updating

ALTA APP MONITOR

The ALTA App includes a flight status monitor that displays information about the health of the ALTA and the various controls that can be selected.

Boot indicates if the SYNAPSE booting process has completed successfully. Any issues that prevented a normal boot are indicated here.

Battery displays the voltage of the battery pack.

Status displays the state of the SYNAPSE flight controller.

Radio displays if the SYNAPSE detects a radio controller signal. A LOS (Loss Of Signal) warning is displayed if no signal is present.

GPS displays if SYNAPSE has resolved a GPS fix or not.

Sats displays the number of GPS satellites in view and being received.

Lock displays whether a position lock is ready, indicating a valid GPS fix and good heading. This is required before the SYNAPSE will allow switching into Position Mode.

Height displays the current height control mode: Manual, Vario if in Height or Position mode and climbing or descending, and Hold.

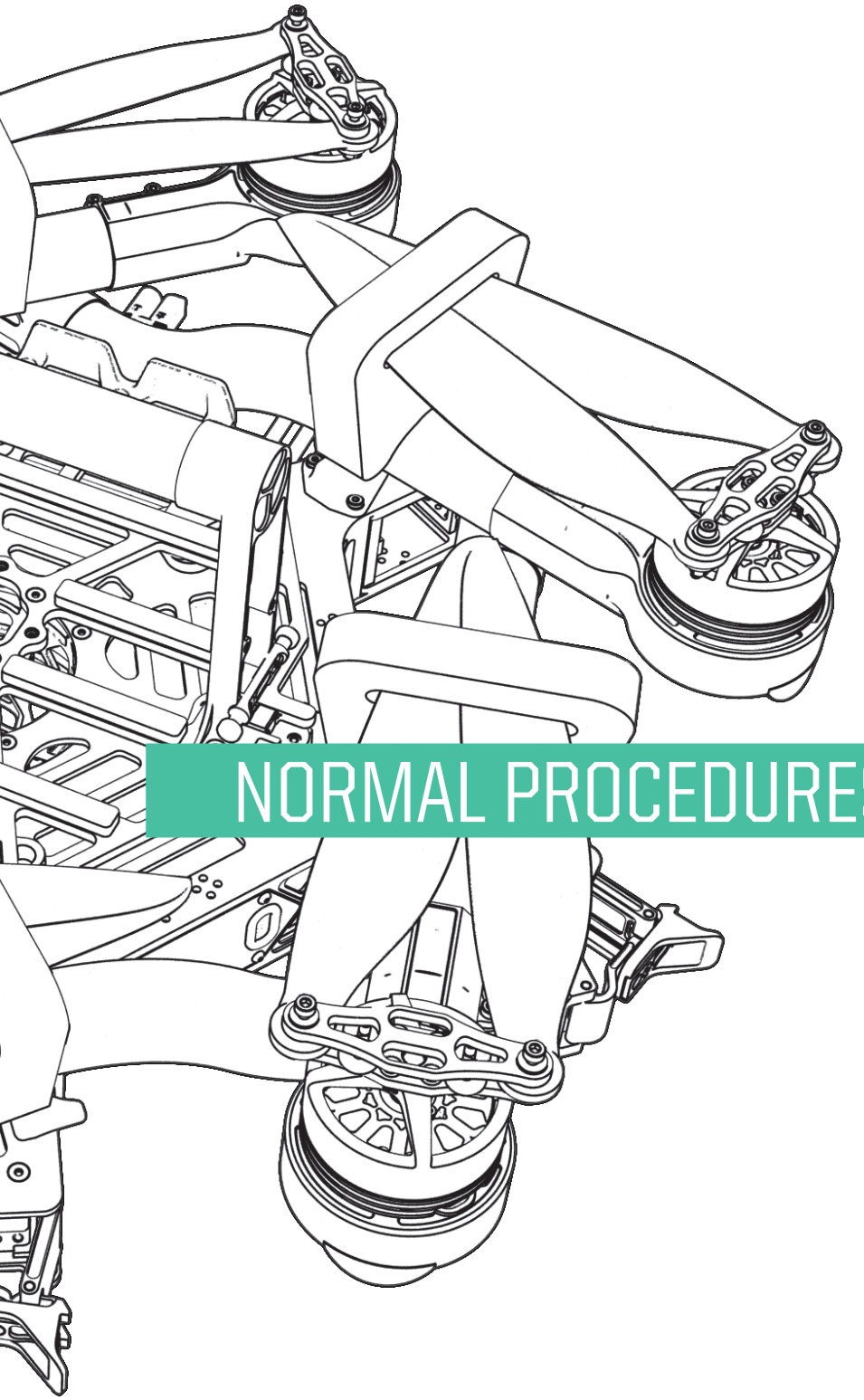
Attitude displays the current attitude control mode.

Position displays the current position control mode: Manual, Velocity if in Position mode and moving across the ground, and Hold

Compass displays the status of the compass and if the SYNAPSE believes the compass readings are good or bad. If Bad, the compass may require recalibration (see the Compass Calibration section in this manual).

Station displays if ALTA is currently over its commanded position over the ground, or if it attempting to fly to it.

Temp displays the temperature of the SYNAPSE flight controller board.



NORMAL PROCEDURES

1.	Aircraft	REMOVE from case
2.	Prop protectors	REMOVE
3.	Boom retention clips	STOW
4.	Booms	UNFOLD
5.	Boom latches	LOCK
6.	Receivers and wiring	CHECK
7.	Isolator cartridges	SELECT and INSTALL as necessary
8.	Payload mounting location	CONFIGURE as necessary

AMPLIFICATION

To set up ALTA for flight, remove it from the case and remove the prop protectors. Stow the six boom retention clips by folding them down. The clips only fold in one direction and are spring-loaded to stay in open and closed detented positions.

Unfolding the booms is most easily accomplished by unfolding opposite pairs partially. Then unfold the opposite boom pairs completely. ALTA can become unbalanced while unfolding booms individually, so unfolding opposite pairs reduces this possibility.

Once unfolded, push on the boom latches until they audibly click, indicating the booms are secure. There should be little to no slop in the hinge. Check that the receivers and the electrical connectors that attach to the receivers are secure.

For information on installing isolator cartridges and setting up payload mounting locations, refer to the Isolator Cartridges and Configuring Top or Bottom Mount sections of this manual.

1.	Payload	SECURED
2.	Isolator Cartridges	CHECK
3.	microSD Card	INSTALLED
4.	Props	CHECK CONDITION, VERIFY TIGHT
5.	Prop Hub	VERIFY SECURE
6.	Motors	CHECK CONDITION
7.	Radio Controller	ON, VERIFY TX BATT
8.	Radio Controller Model	SELECT
9.	Aircraft Placement	AWAY from people and obstacles
10.	Battery Pack Voltage	VERIFY ABOVE 24V
11.	Battery Packs	SECURE
12.	Battery Leads	CHECK CONDITION and CONNECT
13.	Aircraft	KEEP STATIONARY
14.	Flight Controller	INITIALIZED
15.	Status Light	VERIFY SLOW FLASHING WHITE
16.	Orientation Lights	VERIFY FLASHING GREEN
17.	Receivers	VERIFY BOUND
18.	ALTA App	CONNECT
19.	ALTA App Monitor	VERIFY NO WARNINGS
20.	Compass Calibration	AS REQUIRED
21.	Radio Control Range Check	AS REQUIRED

AMPLIFICATION

Check that the payload is secure by checking that the Toad In The Hole quick release lever is pushed in, and that the payload does not slip. Check that all isolator cartridges are locked in place, especially if they have been recently replaced. A microSD card is required to be installed in the GPS/Compass module for reliable compass sensing and data logging.

The blades should be checked for damage, including nicks and scrapes. If a prop has been nicked enough such that it catches a fingernail, it should be replaced. Bolt tightness should be checked by rotating the blade about its length (blade pitch up and down). There should be no slop, and if there is, the bolt and nut should be tightened until the slop is removed. There should be no slop between the prop hub and the motor.

Motors should spin freely, and there should be no grinding or scraping sound from the motor. The inside of the motor should be free of debris.

Always turn on the radio controller before plugging in ALTA. Follow the battery installation guidance in the Battery Installation section of this manual for battery installation instructions.

While the SYNAPSE flight controller initializes, keep the ALTA as stable as possible. If ALTA moves during initialization, it many not boot properly. Wedging a foam prop protector between the stationary gimbal or landing gear and the ALTA frame can be used to stabilize ALTA from spinning during this process.

When it is impossible to initialize ALTA without movement (such as booting on a boat), Motion Booting can be used. It is not recommended to use Motion Booting regularly.

During initialization, the Status Light will quickly flash a sequence of red and white lights. At the end of this process, it will begin slow flashing white, indicating SYNAPSE is ready for arming. The Orientation Lights will also begin flashing green. Verify that all six motors are flashing green, indicating all ESCs initialized successfully.

Verify that there are no flight warnings by connecting to ALTA via the ALTA app and checking on its status from the App. For more information, see the ALTA App section of this manual.

1.	Prop Area	CLEAR
2.	Mode Switch	MANUAL
3.	Home Switch	CENTER POSITION
4.	Radio Controller	VERIFY CORRECT MODEL
5.	Telemetry (if equipped)	CHECK OPERATION
6.	Arm Enable Switch	ENABLE ARM
7.	ALTA	ARM
8.	Status Light	VERIFY OFF
9.	Orientation Lights	VERIFY USER-DEFINED COLOR
10.	Motors	START and VERIFY OPERATION
11.	Flight Controls	VERIFY CORRECT
12.	Throttle	ADVANCE

AMPLIFICATION

Prior to start, check the surrounding area to ensure people and objects are clear of ALTA and its props. Also ensure that there are no people or objects between the ALTA's takeoff location and its intended flight path.

> ⚠ **WARNING**
>
> ALTA's props spin at a high RPM, and the ends of the blades move at high speeds. ALTA's props can cause severe injury or death or cause damage to objects while they are rotating. Always ensure the area surrounding the props and ALTA is clear of people or objects prior to starting the ALTA's motors.

ALTA can only be armed for flight when it is in the Manual Mode, and the Home Switch is in the middle position. If an Arm Enable Switch is configured, it must be placed in an ENABLE ARM position. To arm, hold full low throttle and full left yaw.

> ⚠ **WARNING**
>
> Do not approach ALTA while it is armed.

To start the motors, hold full low throttle and full right yaw. Ensure that all the

motors are spinning. Keep the throttle in the lowest position and move the pitch, roll and yaw controls slightly. ALTA should pitch, roll and yaw slightly due to isolator cartridge flex. Ensure that the ALTA behaves as expected. If it does not, shutdown ALTA and ensure the props are installed in the correct orientation.

⚠ CAUTION

Do not make large yaw commands while on the ground with the inverted landing gear installed. Large yaw commands can cause instability.

After checking flight control directions, advance the throttle to enter a hover.

1.	Mode Switch	MANUAL
2.	Home Switch	CENTER POSITION
3.	Arm Enable Switch	ENABLE DISARM
4.	ESCs and Motors	DISARM and STOP
5.	Arm Enable Switch	DISABLED
6.	Orientation Lights	VERIFY FLASHING GREEN
7.	Status LED	VERIFY SLOW FLASHING WHITE
8.	ALTA App	CHECK for warnings
9.	Batteries	DISCONNECT and REMOVE
10.	Radio Controller Power	AS REQUIRED
11.	Aircraft Condition	INSPECT
12.	Motor and Prop Condition	INSPECT
13.	Battery Condition	INSPECT

AMPLIFICATION

Upon landing, disarm the motors by holding full low throttle and full left yaw. This is typically done on the left radio control stick by moving it to the bottom left corner with mode 2 controllers. Disarming can only be done while in Manual Mode. If configured, set the Arm Enable Switch to ENABLE DISARM. Once the motors are disarmed, the Orientations Lights will flash green and the Status Light will slowly flash white, indicating it is safe to approach ALTA.

> ⚠ **WARNING**
>
> Only approach ALTA after confirming that it is disarmed by verifying the Status Light and Orientation Light colors.

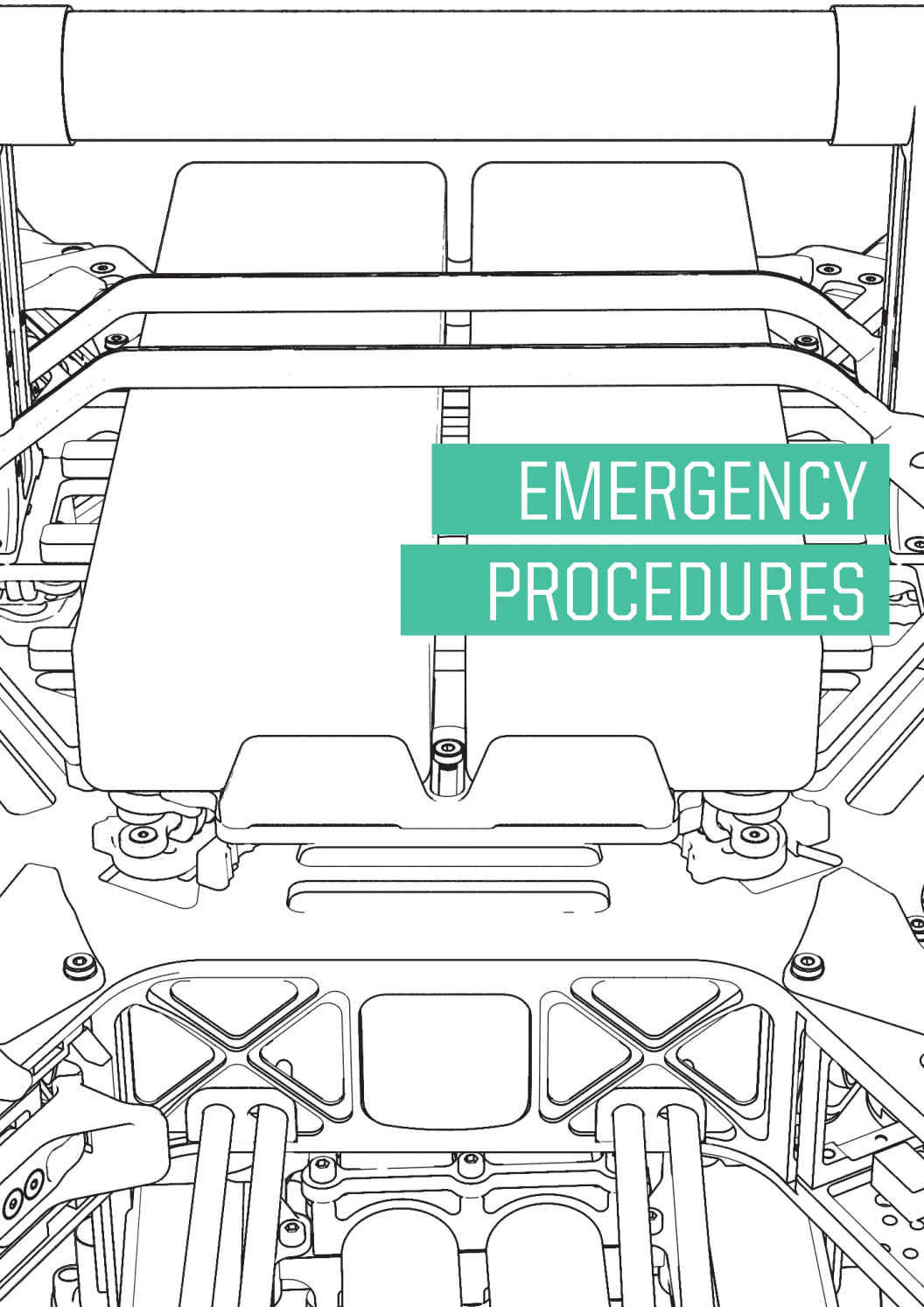
The downwash from the props can disturb debris. This debris can be ingested by the props or motors and cause damage. After the flight, ensure there is no damage to the props and that the motors still spin freely and quietly. Take extra care when operating in areas with large amounts of debris, such as in sand, dirt, or gravel.

After flight is also a good time to check a battery pack's condition. Always refer to the battery manufacturer's recommendations for inspection and replacement intervals or requirements.

1.	Props	FOLD and PLACE inline with booms
2.	Prop Protectors	INSTALL
3.	Boom Latches	UNLOCK
4.	Booms	FOLD
5.	Boom Retention Clips	EXTEND
6.	Payload	REMOVE
7.	ALTA	INSERT into case

AMPLIFICATION

Packing ALTA is similar to the unpacking process. Keeping ALTA on the payload or landing gear facilitates the process as ALTA may be turned on the Toad In The Hole adapter while folding the props and booms. Make sure that the handle is aligned front-to-back when putting ALTA in the included case, and that the battery leads are facing to the right.



EMERGENCY PROCEDURES

EMERGENCY GUIDANCE

The emergency procedures listed in this section are the recommended practices for handling the aircraft in the event of an aircraft emergency. This guidance should be considered and applied as necessary.

The risk of an emergency occurring can be reduced substantially through proper aircraft maintenance, by performing thorough inspections before and after all flights, and with careful pre-flight planning.

Emergency situations are dynamic events, and not all conditions or procedures can be anticipated or applied during the event. These procedures are not a substitute for thorough understanding of aircraft systems and sound pilot judgement.

In general, if an emergency occurs, three basic actions can be applied to most situations:

Maintain aircraft control - Small emergencies can quickly escalate if the pilot is distracted attempting to determine or troubleshoot the problem. Always maintain visual contact with the aircraft during an emergency to reduce the likelihood of disorientation.

Analyze the situation - Once the aircraft is stabilized, begin to assess the cause of the emergency if practical.

Take appropriate action - In many cases, the appropriate action will be to land the aircraft as soon as possible. Always consider the safety of yourself and others before attempting to save the aircraft in an emergency.

1.	Control Inputs	NEUTRALIZE
2.	Mode Switch	POSITION
3.	Yaw	NOSE AWAY
4.	Roll	VERIFY DIRECTION

AMPLIFICATION

Regaining spatial orientation as quickly as possible is most important. In disorientation situations, control inputs will not give the expected result, so neutralize them. If a good GPS signal is available, enable Position Mode so ALTA will stay in a one place.

Use yaw only to reorient ALTA so the nose is pointed away, then use the roll control to verify the orientation of ALTA.

1.	Control Inputs	NEUTRALIZE
2.	Mode Switch	MANUAL
	If the problem persists	
3.	ALTA	LAND as soon as possible

AMPLIFICATION

If the ALTA behaves unexpectedly, neutralize control inputs and observe ALTA. If it is still flying in an uncommanded manner, switch to Manual mode if it is in Height or Position modes. In most cases, unexpected behavior is due to erroneous sensor readings, or degraded GPS signal reception.

If the behavior occurred while in Manual mode, land as soon as possible and check the ALTA App for any warnings.

BATTERY EXHAUSTION

If battery cell voltage is between Alarm Voltage and Land Voltage

1.	Status Light	Illuminates red (solid or blinking)
2.	ALTA	LAND as soon as possible

If battery cell voltage is below Land Voltage

1.	ALTA	Begins Autoland
2.	Pitch and Roll	MANEUVER away from people or objects

AMPLIFICATION

If the battery cell voltage drops below the Alarm Voltage, the Status Light will turn solid red in Manual Mode, or turn blinking red if holding position or altitude. Terminate the flight and land as soon as possible.

In the event the cell voltage drops below the Land Voltage, ALTA will begin to auto land. However, pitch and roll commands are still active. During the time ALTA is descending, use pitch and roll to avoid people or objects during the descent and landing.

1.	Mode Switch	MANUAL
2.	ALTA	LAND as soon as possible
3.	ALTA App	OPEN MONITOR

AMPLIFICATION

The Status Light can turn red, indicating a warning, for a number of different reasons. It is always recommended to land as soon as possible and investigate the problem while ALTA is on the ground.

LOSS OF RADIO CONTROL SIGNAL

1.	Controller Battery	CHECK
2.	Controller Antenna	REPOSITION
3.	Mode Switch	POSITION
4.	Home Switch	RETURN-TO-HOME

AMPLIFICATION

Loss of Signal (LOS) can occur if the radio controller stops transmitting a signal, or if ALTA is too far away to receive it. In the event ALTA detects a LOS, it will automatically execute a Return-to-Home or Autoland as configured in the App. However, it is always recommended to attempt to regain signal link with ALTA to keep the pilot in control of the aircraft.

Move the antenna orientation for best signal strength. Ensure the transmitter antenna matches the direction of the receiver antennae. Move the transmitter away from objects to get a clear line-of-sight to ALTA.

Setup the Mode and Home switches to enable Return-To-Home so ALTA will continue to approach the starting point and have a higher likelihood of regaining signal reception.

NOTE

If efforts to regain control signal are unsuccessful, ALTA will begin the Return-To-Home and Autoland sequence.

1.	Control Inputs	AS REQUIRED
2.	Visual Contact	ESTABLISH
3.	ALTA	POSITION for optimal signal reception

If visual contact or FPV signal is not reestablished

1.	Mode Switch	POSITION
2.	Home Switch	RETURN TO HOME
3.	Throttle	AS REQUIRED

AMPLIFICATION

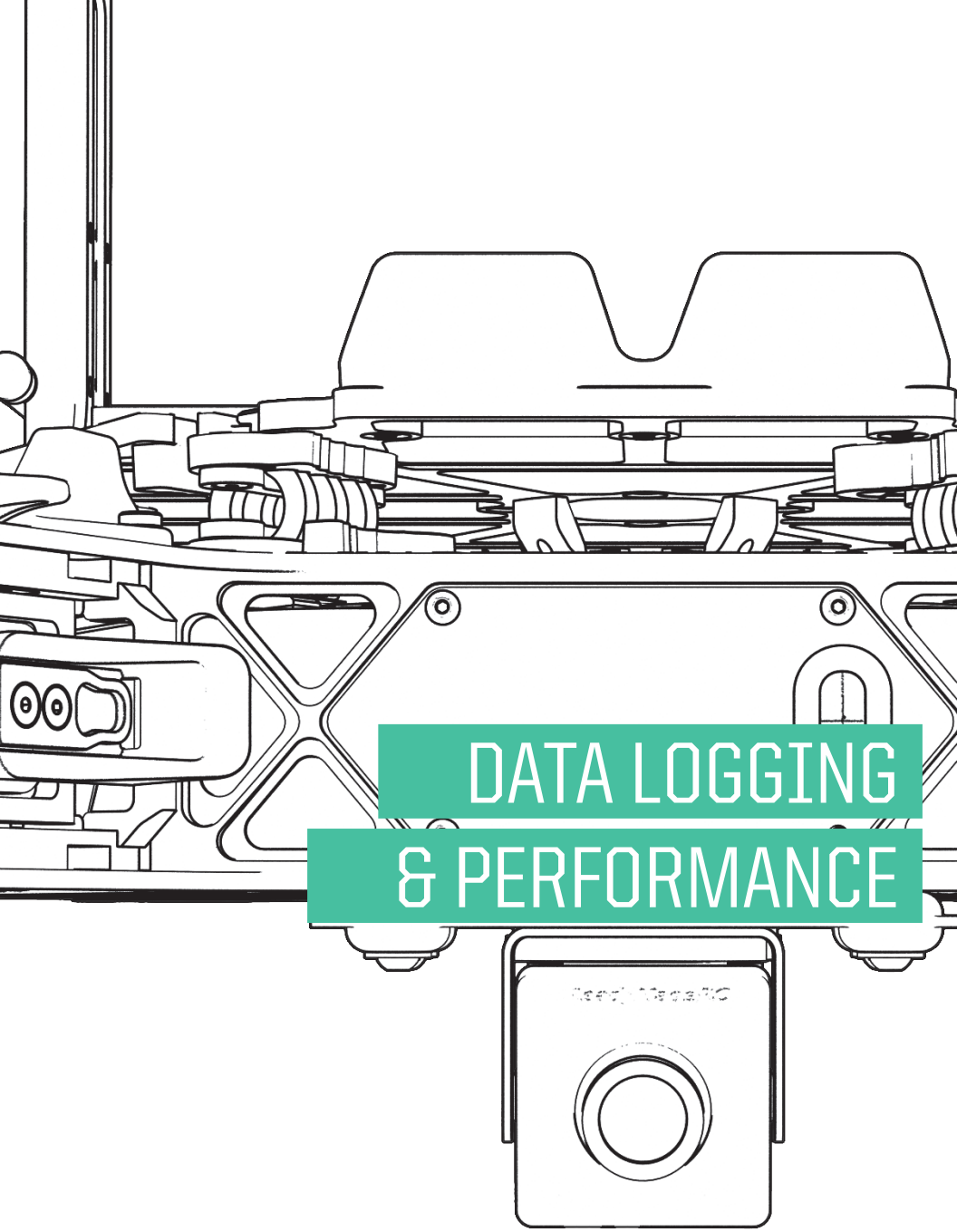
An FPV Loss of Signal (LOS) can occur if the aircraft flies out of range, or if it flies behind an object that interrupts the signal line of sight. Regaining visual contact is the preferred method to reestablish control of the aircraft, either with the pilot seeing the aircraft, or by the use of a second visual observer.

Yawing the aircraft can help signal reception if the body of the aircraft is blocking the line of sight between the transmitter and receiver antennas.

If FPV signal or visual contact cannot be reestablished, enabling Return To Home can be used to bring the aircraft back to signal reception range.

⚠ WARNING

It is the responsibility of the pilot to see and avoid other aircraft, people or obstacles. Always maintain direct line of sight with ALTA during flight, use visual observers as operations require, and follow local regulations regarding see-and-avoid requirements.



DATA LOGGING & PERFORMANCE

DATA LOGGING

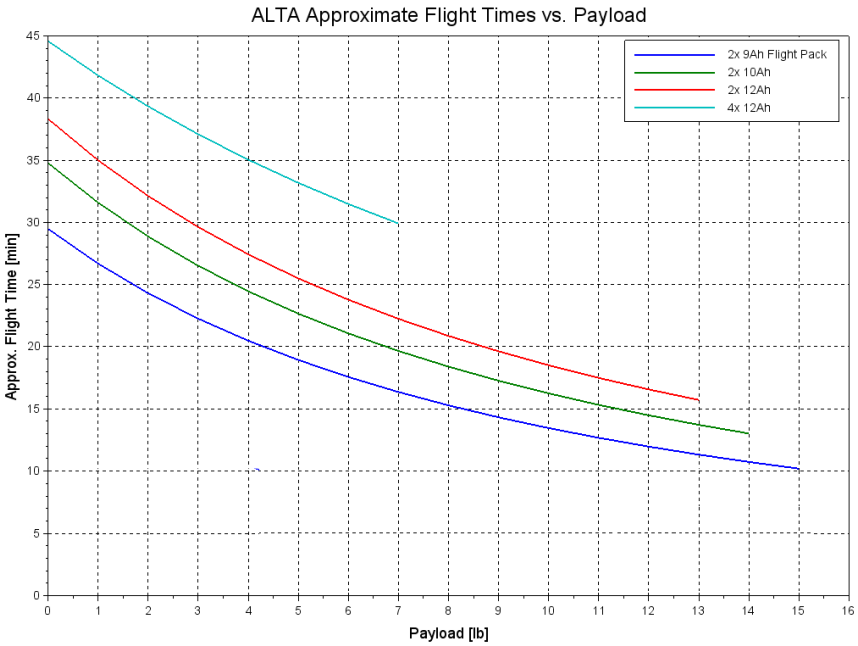
ALTA automatically logs flight and control data when ALTA is armed for flight. Data is recorded as a .csv file at a rate of 25 Hz on a microSD card installed on the top of the GPS/Compass module. A table of recorded data is included in Appendix B.

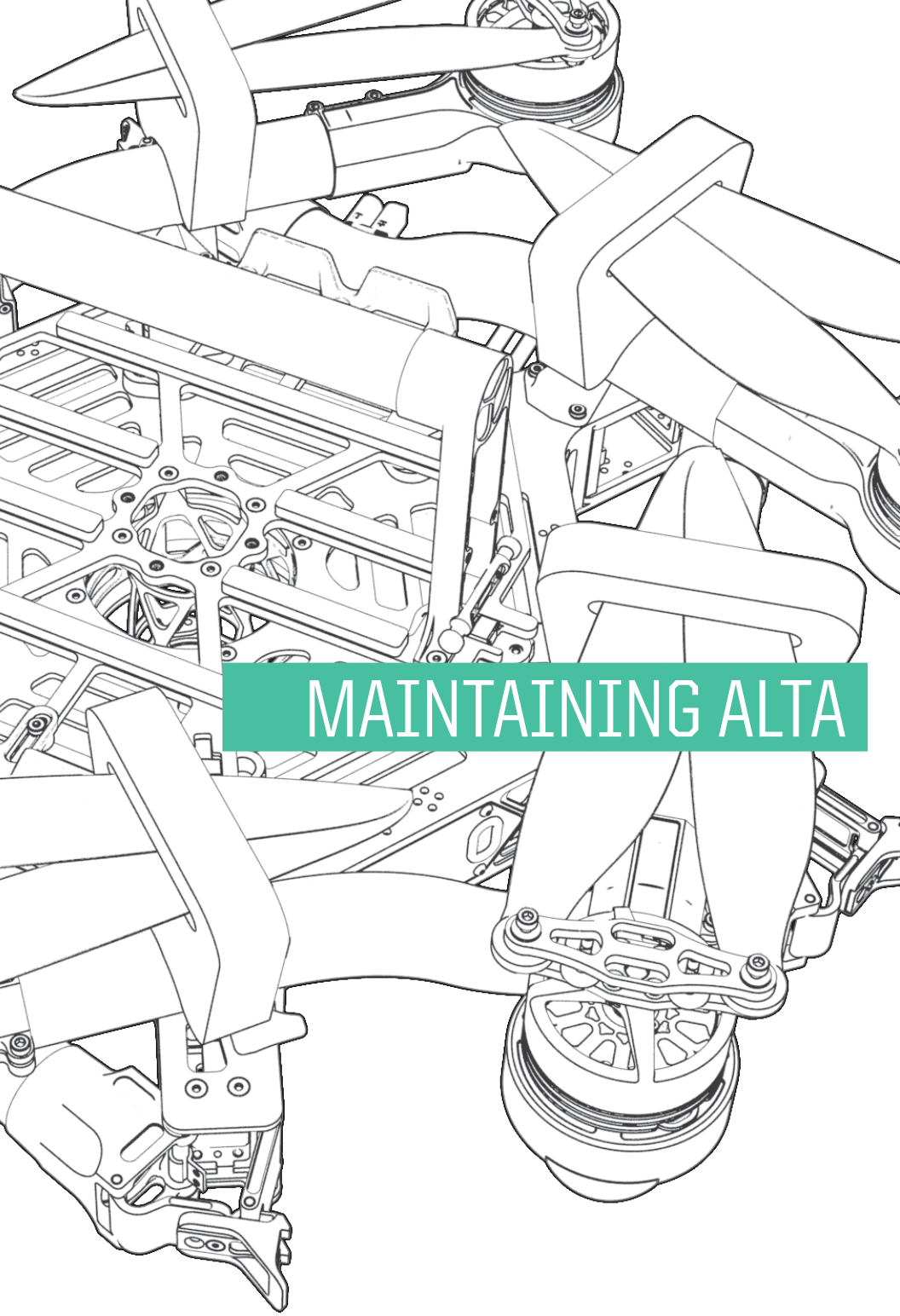
PERFORMANCE

WEIGHT / ENDURANCE PERFORMANCE DATA

Conditions:

Altitude	Sea Level, ISA
Winds	Zero





MAINTAINING ALTA

USE OF THREADLOCKER

Bolts and screws that are called out in this manual to regularly remove or replace typically do not require use of a threadlock compound. This includes the screws holding on the handle, battery retention strap studs, battery stops, closeout panels, the top male Toad In The Hole adapter. In addition, fasteners that attach to nuts with a nylon locking feature (nylock nuts) do not require threadlocker.

All structural fasteners require the use of threadlock. This includes chassis screws, lower male Toad In The Hole adapter and motor attachment fasteners. In addition, the four M3 x 8 socket head bolts that attach the folding propeller to the motor require threadlocker. Typically, a medium threadlocker (such as Loctite Blue 243) is used on structural fasteners.

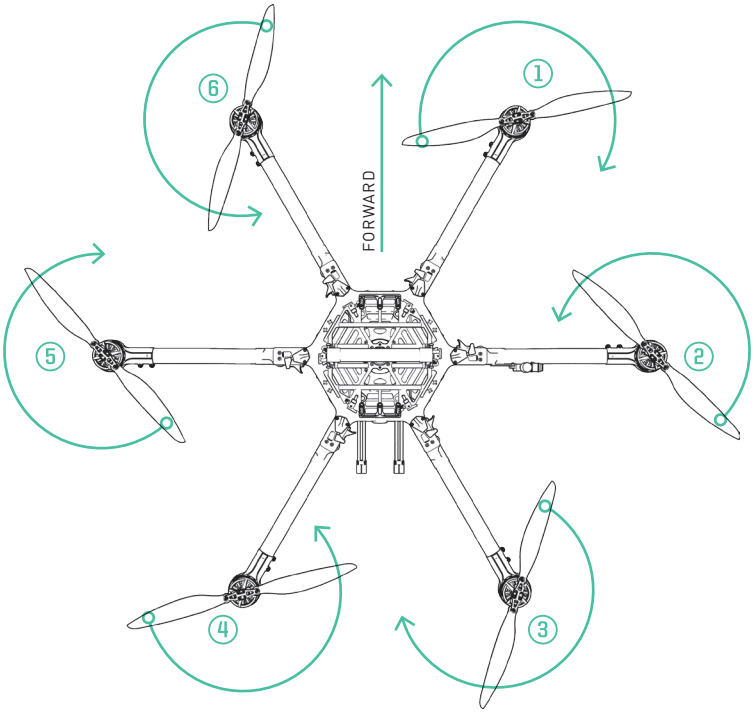
BOLT INSTALLATION

The Freefly hex drivers included with ALTA are designed to help limit the torque that can be applied to each bolt.

Thread all fasteners into their respective holes until “snug”. This is when the fastener head bottoms out and lightly clamps the two mating parts together

To prevent tightening the bolts excessively and damaging the bolts or parts, it is suggested to hold the wrench in your hand, and twist the wrench from the smaller dia knurled section of the tool between your thumb and index finger for small fasteners (under size M3) or with your thumb and two forefingers for larger fasteners (size M3 and larger).

PROPELLERS



Propeller blades should be removed when making a change to the configuration of the ALTA to prevent propeller strikes in the event of unintentional motor starts. Propeller blades should be replaced on an as needed basis if they become damaged. Generally, a nick on the leading edge that is large enough to catch a fingernail indicates that the prop should be replaced. If the blade composite structure becomes delaminated, the propeller blade should be replaced.

Freefly makes folding propeller assemblies available that include the blades and prop hub fully assembled. They are available in clockwise and counter-clockwise orientations.

The folding props are installed on the motors with four M3×8 socket head bolts.

⚠ CAUTION

Always use a threadlocking compound on the bolt threads that attach the propeller hub to the motor.

Odd numbered booms (1, 3 and 5) use clockwise rotating props when looking from the top down, and even numbered booms (2, 4 and 6) use counterclockwise rotating props.

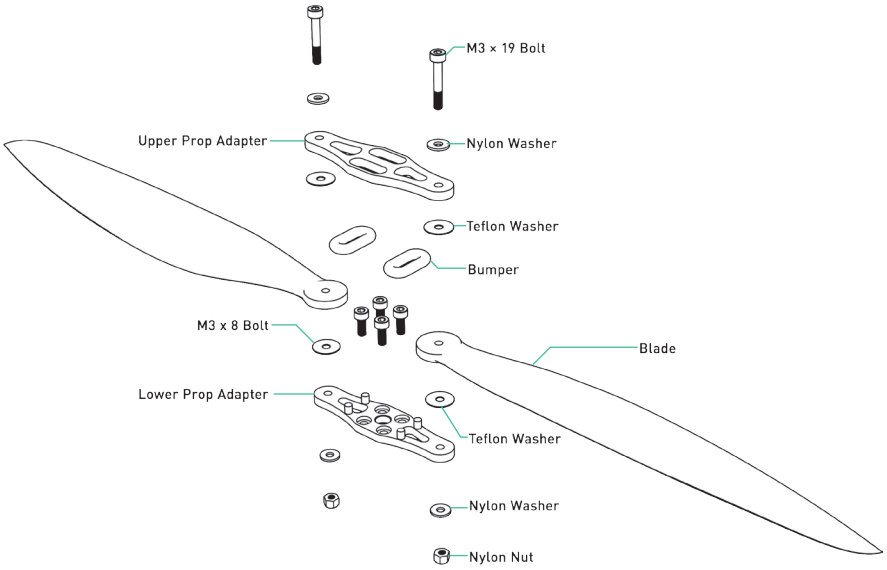
⚠ WARNING

Always check to ensure the correct prop rotation direction and correct propeller prior to flight. Props that spin in the incorrect direction will cause ALTA to be uncontrollable.

REPLACING PROPELLER BUMPERS

Under normal use, propeller bumpers may split and fall out of the folding propeller assembly. Six spare bumpers are provided with the ALTA. To replace the bumper, disassembly of the folding propeller is required.

Start by removing the M3 x 19 bolt and nylon nut. Pull off the upper prop adapter. The two bumpers are held in place by circular features in the lower prop adapter. Replace the worn or split bumper with a new one.



To reassemble, follow the part layout in the figure above. Note that there are two different types of washers, one made of nylon and the other made of PTFE. The nylon washer is smaller in width and thicker and is installed between the nut or bolt head and the two prop adapters. The PTFE washer is wider and thinner and is installed between the prop blades and prop adapters.

EVERY 15 FLIGHTS

ALTA is designed to be as maintenance-free as is possible.

It is recommended to check ALTA's fasteners regularly. This check should occur roughly after every 15 flights, dependent upon the level of vibration ALTA experiences in flight or during handling. To check ALTA's fasteners, apply a tightening torque to each fastener on the chassis using the supplied hex drivers. The fasteners should not slip.

If a fastener does slip, tighten it using the methods described in the Bolt Installation section. Do not apply additional threadlocking compound unless the bolt has repeatedly come loose.

REPLACEMENT OF PARTS

Spare or replacement parts are available for sale separately at www.freeflysystems.com. Please refer to the company store for a current listing of all available spare parts.

NOTE

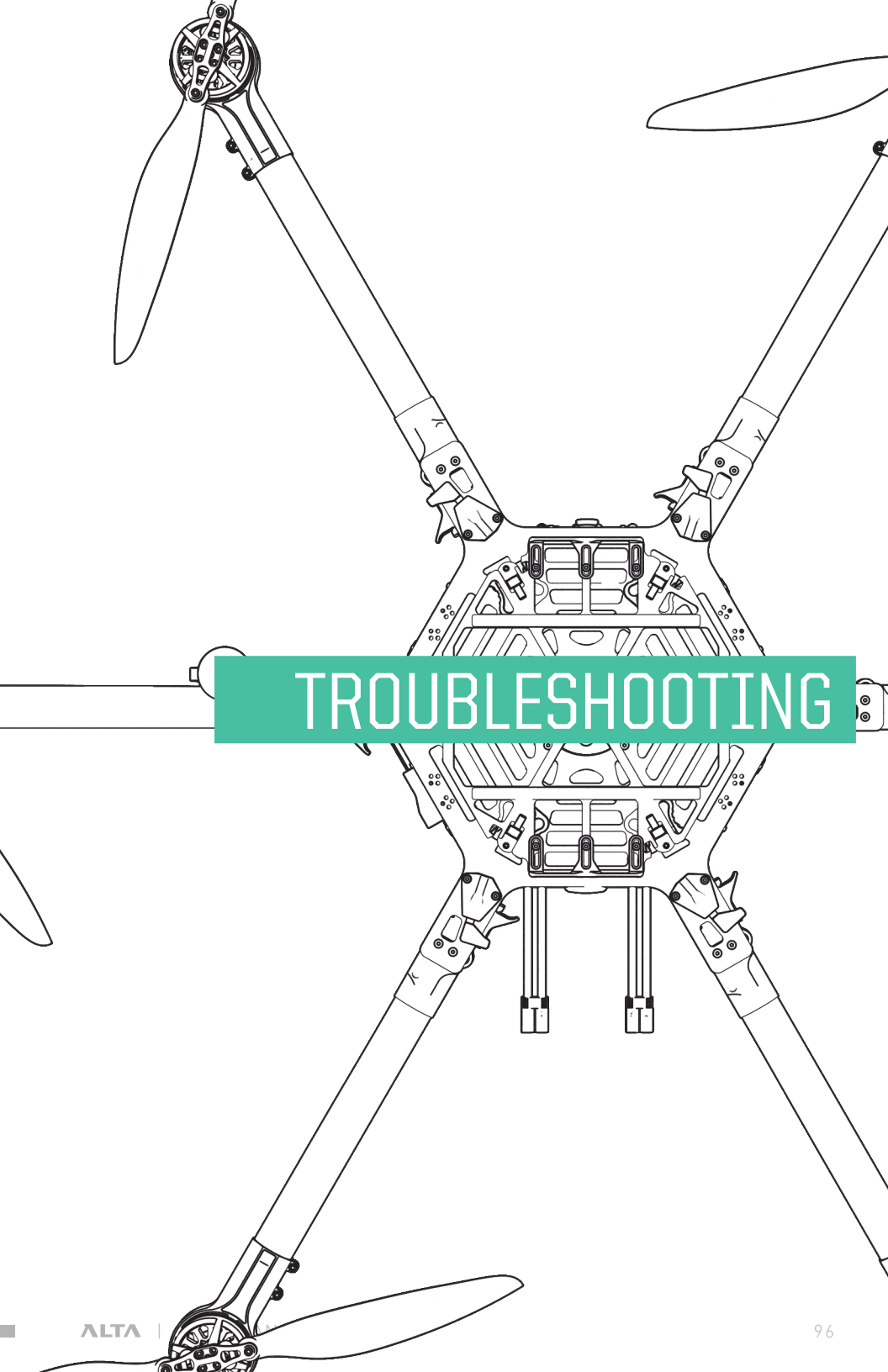
Carefully follow in-app instructions for saving and restoring ALTA configuration settings during the firmware update process.

⚠ WARNING

Remove propellers before performing a firmware update.
Test radio channels, arming and disarming behavior after firmware updates to ensure radio mapping has been preserved.
Incorrect radio mapping can lead to loss of control.

SYNAPSE firmware is updated using the ALTA App. New app updates may include new firmware installations. To update firmware:

1. Provide power to ALTA
   a. Install and plug in a fully charged flight pack or
   b. Plug in the USB-Futaba cable to an available receiver port (Futaba and PPM receivers only)
2. Open the ALTA App
3. Open Monitor → Updates
4. The latest firmware included with the app release is compared with the ALTA firmware. If a new release is available, the app will provide a notification
5. Tap the Install button in the App if an update is available
6. Wait until the firmware is loaded and ALTA has booted—
   Do not power down ALTA during this time
7. Reload saved configuration



TROUBLESHOOTING

GENERAL WARNINGS

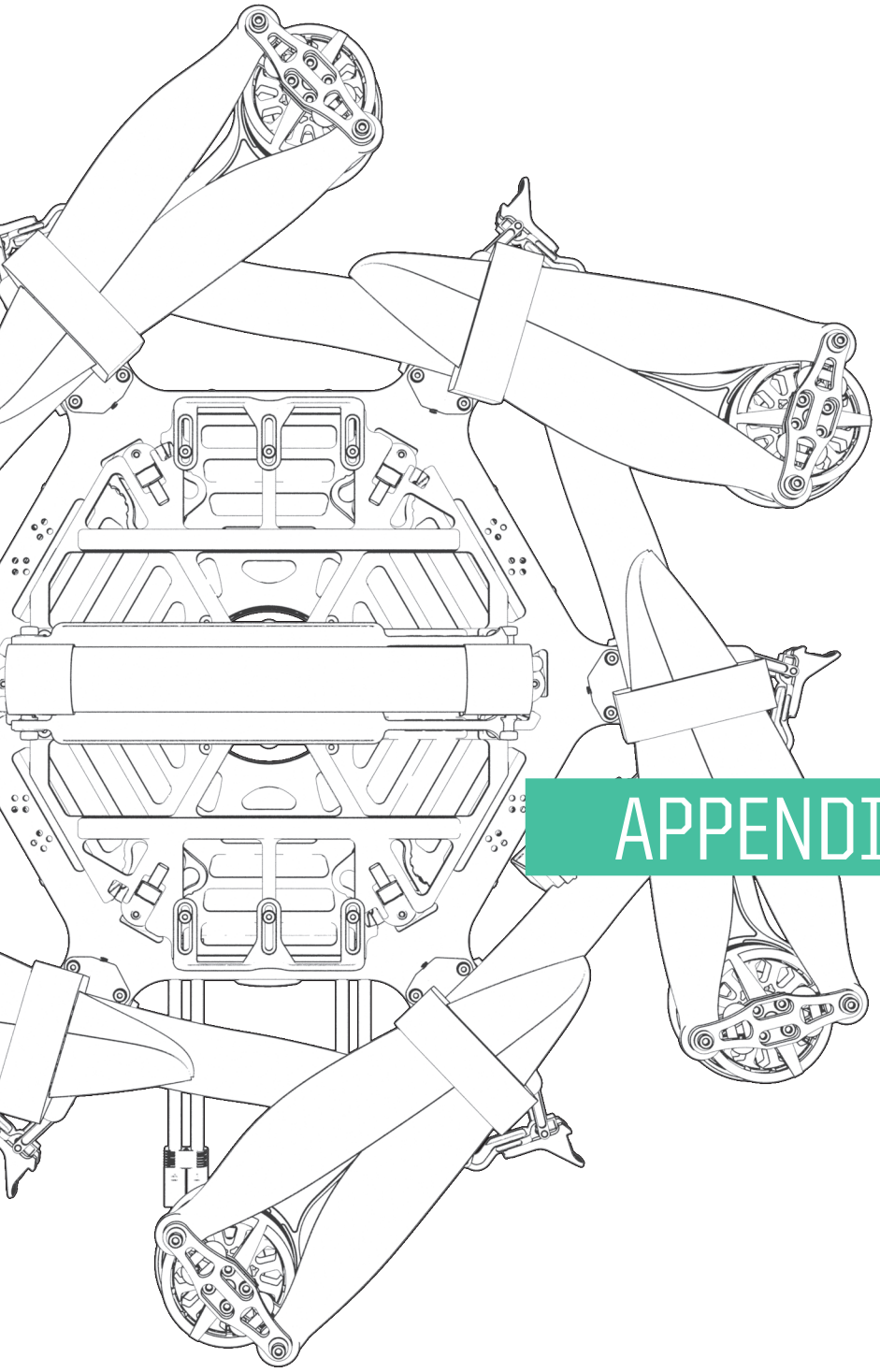
SYMPTOM	POTENTIAL CAUSE	POTENTIAL SOLUTION
Compass Warning	microSD card is missing	Check the microSD card is installed
	Compass calibration is invalid	Recalibrate the compass
GPS Warning	GPS/Compass Unit has become disconnected	Check the GPS/Compass unit wiring for damage

FLIGHT CONTROLLER

SYMPTOM	POTENTIAL CAUSE	POTENTIAL SOLUTION
ALTA will not arm	ALTA Home Switch not in middle position	Move Home Switch to middle position
	ALTA Mode Switch not in Manual	Move Mode Switch to manual
	ALTA Arm Enable Switch not on Allow Arm	Move Arm Enable Switch to Allow Arm
	Radio not bound	Follow radio controller manufacturer's binding procedure
	Radio not mapped properly	Check ALTA App radio mapping charts for correct behavior Adjust mapping as necessary
	SYNAPSE boot not successful	Power cycle ALTA. Ensure it does not move during boot If ALTA must move during boot (such as on a moving platform), use Motion Booting
Motors will not stop	ALTA Mode Switch not in Manual	Move Mode Switch to manual
	ALTA Arm Enable Switch not on Allow Disarm	Move Arm Enable Switch to Allow Disarm

FLIGHT BEHAVIOR

SYMPTOM	POTENTIAL CAUSE	POTENTIAL SOLUTION
ALTA does not maintain level pitch or roll	Pitch or Roll Trim position not set	Use the ALTA app to set the appropriate pitch and roll trim
ALTA does not maintain heading	ALTA yaw during boot	Re-initialize SYNAPSE while keeping ALTA stationary in all directions
ALTA circles a point in Position Mode	Compass calibration is invalid	Recalibrate the compass
	Position Hold tuning values too high	Reduce Position Hold tuning values, starting with Position Hold Strength
ALTA does not track straight in Position Mode	Compass calibration invalid	Perform a manual compass calibration
Unexpected flight behavior	Tuning too high or too low	Revert tuning to the last known working configuration Set tuning back to default values



APPENDIX

APPENDIX A. DEFAULT TUNING VALUES

PARAMETER GROUP	PARAMETER	DEFAULT VALUE
Attitude	Pitch/Roll Stiffness	65
	Pitch/Roll Hold Strength	50
	Yaw Stiffness	100
	Yaw Hold Strength	100
	Roll Trim	0
	Pitch Trim	0
	Maximum Pitch/Roll Angle	40°
	Maximum Yaw Rate	100°/sec
Height	Vertical Stiffness	20
	Hold Strength	80
	Hover Throttle	14.0V
	Ceiling	118 meters
	Climb Rate	3 meters/sec
	GPS Height Correction	On
Position	Horizontal Stiffness	30
	Hold Strength	40
	Maximum G	0.3
	Range	500 meters
	GPS Angle	30°
	GPS Speed	5 meters/sec
Safety	Alarm Voltage	3.5V
	Land Voltage	3.2V
	Safe Height	15 meters
	Autoland Descent Rate	-0.5 meters/sec
	RTH Speed	3 meters/sec

APPENDIX B. DATA LOGGING FIELDS

FIELD	UNITS	DESCRIPTION
Reading	Unitless	An indexed identifier assigned to data points
IMU Time	Seconds	The number of seconds from arming ALTA
GPS Time	HH:MM:SS	The Universal Coordinated Time determined by received GPS signals.
GPS Longitude	Degrees * 10^7	GPS determined longitude multiplied by 10^7
GPS Latitude	Degrees * 10^7	GPS determined latitude multiplied by 10^7
GPS Height	meters	Height above the WGS84 reference ellipsoid
GPS Course	degrees	The ground track of ALTA in degrees from true north.
GPS Position North	meters	The distance ALTA traveled north from the starting point. A negative number indicates southward travel.
GPS Position East	meters	The distance ALTA traveled east from the starting point. A negative number indicates westward travel.
GPS Position Up	meters	The distance ALTA traveled above the starting point. A negative number indicates downward travel.
GPS Velocity North	meters / second	The GPS derived northward velocity component of ALTA.
GPS Velocity East	meters / second	The GPS derived eastward velocity component of ALTA.
GPS Velocity Up	meters / second	The GPS derived upward velocity component of ALTA
GPS Acceleration North	meters / second^2	The GPS derived northward acceleration
GPS Acceleration East	meters / second^2	The GPS derived eastward acceleration
GPS Acceleration Up	meters / second^2	The GPS derived upward acceleration, without gravitational acceleration

IMU Position North	meters	The IMU derived dead-reckoned distance ALTA has traveled northward
IMU Position East	meters	The IMU derived dead-reckoned distance ALTA has traveled eastward
IMU Position Up	meters	The IMU derived dead-reckoned distance ALTA has traveled upward
IMU Velocity North	meters / second	The IMU derived northward velocity component of ALTA.
IMU Velocity East	meters / second	The IMU derived eastward velocity component of ALTA.
IMU Velocity Up	meters / second	The IMU derived upward velocity component of ALTA.
IMU Acceleration North	meters / second^2	The IMU derived northward acceleration
IMU Acceleration East	meters / second^2	The IMU derived eastward acceleration
IMU Acceleration Up	meters / second^2	The IMU derived upward acceleration, without gravitational acceleration
IMU Roll	degrees	The IMU derived roll angle where positive values indicate roll right
IMU Pitch	degrees	The IMU derived pitch angle where positive values indicate pitch up
IMU Yaw	degrees	The IMU derived yaw angle where positive values are eastward and negative values westward
IMU Roll Rate	degrees / second	The IMU derived roll rate where positive values are roll rightward
IMU Pitch Rate	degrees / second	The IMU derived pitch rate where positive values are pitch upward
IMU Yaw Rate	degrees / second	The IMU derived yaw rate where positive values are clockwise looking down on the vehicle
IMU Acceleration X	G	The IMU derived body acceleration where positive values are in a forwards direction
IMU Acceleration Y	G	The IMU derived body acceleration where positive values are in a rightwards direction

IMU Acceleration Z	G	The IMU derived body acceleration where positive values are in an upwards direction and excludes gravity
Compass X	Unitless	A component of a unit magnetic vector with positive values directed to the front when front is pointing Northward
Compass Y	Unitless	A component of a unit magnetic vector with positive values directed to the right when front is pointing Westward
Compass Z	Unitless	A component of a unit magnetic vector with positive values directed to down when the underside is pointing Northward
Position Command North	m	The position control loop set point in a Northerly direction referenced to take-off location
Position Command East	m	The position control loop set point in an Easterly direction referenced to take-off location
Position Command Up	m	The position control loop set point in an Upwards direction referenced to the take-off location
Velocity Command North	m/s	The velocity control loop set point in an Northwards direction
Velocity Command East	m/s	The velocity control loops set point in an Eastwards direction
Velocity Command Up	m/s	The velocity control loop set point in an Upwards direction
Acceleration Command East	m/s^2	The acceleration control loop set point in a Easterly direction
Acceleration Command North	m/s^2	The acceleration control loop set point in a Northerly direction
Acceleration Command Up	m/s^2	The acceleration control loop set point in an Upwards direction
Roll Command	deg	The roll control loop set point where increasing values are roll right right
Pitch Command	deg	The pitch control loop set point where increasing values are pitch up
Yaw Command	deg	The yaw control loop set point where positive values are for an Easterly heading and negative for Westerly

Roll Rate Command	deg/s	The roll rate control loop set point where positive values are for rolling rightwards
Pitch Rate Command	deg/s	The pitch rate control loop set point where positive values are for pitching upwards
Yaw Rate Command	deg/s	The yaw rate control loop setpoint where positive values are rotating clockwise looking from the machine top
Radio Roll	us	RC pulse width 1000-2000us where increasing values are for roll right
Radio Pitch	us	RC pulse width 1000-2000us where increasing values are for pitch up
Radio Yaw	us	RC pulse width 1000-2000us where increasing values are for yaw to the right
Radio Throttle	us	RC pulse width 1000-2000us where increasing values are for increased throttle
Radio Mode	us	RC pulse width 1000-2000us where values near: 1000us = Open Loop 1500us = Closed Loop - height hold 2000us = Closed Loop - height and position hold
Roll Control	a.u.	Control loop calculation for roll axis
Pitch Control	a.u.	Control loop calculation for pitch axis
Yaw Control	a.u.	Control loop calculation for yaw axis
Climb Control	a.u.	Control loop calculation for lifting thrust
Motor Command 1-6	Unitless	Scaled 0-1 representing demanded thrust from motor
Motor speed 1-6	RPM	Propeller speed at last telemetry update
Motor Voltage 1-6	Volts	Bus voltage measured at ESC from last telemetry update
Motor Current 1-6	Amps	Motor field current measured at ESC from last telemetry update
Motor Power 1-6	Watts	Measured ESC power consumption

Motor Energy 1-6	Watt-hours	Integrated ESC power consumption - can be used to compare motor efficiencies or thrust skew
Motor Accel 1-6	a.u.	High pass filtered RMS vibration level measured at ESC - can be used to compare motor / propeller imbalance
Motor Temp 1-6	°C	ESC temperature measured from last telemetry update
Motor Status 1-6	bit-field	ESC fault condition monitor
GPS Sats	Satellites	Number of satellites used for position calculation by GPS
GPS Hacc	meters	Horizontal position accuracy reported by GPS
GPS Sacc	meters / second	Horizontal speed accuracy reported by GPS
Voltage	Volts	Main battery voltage measured by the flight controller
Current	Amps	Total battery current inferred from ESC measurements
Power	Watts	Total battery power
Energy	Watt-hours	Integrated battery power - to be used in conjunction with battery recharge measurements - ascertaining battery health and expected flight times
Temperature	°C	Flight controller PCB temperature
Barometric Altitude	meters	Height above take-off location derived by pressure measurement
Status	a.u.	Flight controller status - indicating things like auto-land
Fail	bitfield	Machine alarm register indicating particular system failures
GPS Loss of Signal	binary	Declared if GPS signal is not adequate for safe position hold
Radio A Drops	number	Accumulated signal drops from radio A
Radio B Drops	number	Accumulated signal drops from radio B
Magnetometer Bad	binary	Alarm indicating compass magnitude is corrupted
Position Lock	binary	Status indicating position estimation filter has locked
Heading Lock	binary	Status indicating heading lock is active

Attitude Mode	register	Status indicating angle or rate control mode
Position Lock 2	register	Status indicating position control mode
Height Lock	register	Status indicating height control mode
CRC Failures	number	Internal communication errors